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THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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Robert Jameson

THE

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BIOGRAPHICAL MEMOIR OF

THE LATE PROFESSOR JAMESON,

REGIUS PROFESSOR OF NATURAL HISTORY, LECTURER ON MINERALOGY, AND KEEPER OF THE MUSEUM IN THE UNIVERSITY OF EDINBURGH;

Fellow of the Royal Societies of London and Edinburgh; Honorary Member of the Royal Irish Academy; of the Royal Society of Sciences of Denmark; of the Royal Academy of Sciences of Berlin; of the Royal Academy of Naples; of the Geological Society of France; Honorary Member of the Asiatic Society of Calcutta; Fellow of the Royal Linnean, and of the Geological Societies of London; of the Royal Geological Society of Cornwall, and of the Cambridge Philosophical Society; of the Antiquarian, Wernerian Natural History, Royal Medical, Royal Physical, and Horticultural Societies of Edinburgh; of the Highland and Agricultural Society of Scotland; of the Antiquarian and Literary Society of Perth; of the Statistical Society of Glasgow; of the Royal Dublin Society; of the York, Bristol, Cambrian, Whitby, Northern, and Cork Institutions; of the Natural History Society of Northumberland, Durham, and Newcastle; of the Imperial Pharmaceutical Society of Petersburgh; of the Natural History Society of Wetterau; of the Mineralogical Society of Jena; of the Royal Mineralogical Society of Dresden; of the Natural History Society of Paris; of the Philomathic Society of Paris; of the Natural History Society of Calvados; of the Senkenberg Society of Natural History; of the Society of Natural Sciences and Medicine of Heidelberg; Honorary Member of the Literary and Philosophical Society of New York; of the New York Historical Society; of the American Antiquarian Society; of the Academy of Natural Sciences of Philadelphia; of the Lyceum of Natural History of New York; of the Natural History Society of Montreal; of the Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanical Arts; of the Geological Society of Pennsylvania; of the Boston Society of Natural History of the United States; of the South African Institution of the Cape of Good Hope; Honorary Member of the Statistical Society of France; Member of the Entomological Society of Stettin, and other learned Societies.

By the death of ROBERT JAMESON, the University of Edinburgh has lost a great master and a good man, one of the true philosophers of the old school; "one who, (in the words of his colleague, the Very Rev. Principal Lee,) for a half century, has filled a most eminent place among the brightest ornaments of this University, and who, indeed, has been entitled to be universally recognised as one of the most ardent, and one of the most successful contributors to the advancement of science in this enlightened age." In fact, Robert Jameson was the Father of Modern Natural History. His loss is deeply to be deplored,—a man of the same grasp of mind, devoted to physical science, only at times appears to enlighten his age. He was eminently fitted for the station which he had filled with so much success. He had fine natural talents, which had been carefully cultivated, and were applied with vigour to the studies in which he delighted. He was a careful observer, a comprehensive thinker, and his industry was unwearied. He was never satisfied with loose and general notions upon any subject; his range of information was wide, and what he knew he knew thoroughly. He was practical, and anxious to be useful, in days when science and practice stood apart, as if they were two repellent forces. He did much towards neutralizing these states; and was one of the pioneers to whom we are indebted for that union of science and practice which is now the prevailing feature of our time.

Professor Edward Forbes, the distinguished successor of Professor Jameson, says:—"To my illustrious predecessor and master, who passed from amongst us ripe in years, honours, and fame, so lately, I gratefully record my acknowledgments for the encouragement of those tastes, and the founding of that knowledge which have proved to me a chief delight. Who that, in time past, was his pupil, and found pleasure in the study of any department of Natural History, can ever forget his enthusiastic zeal, his wonderful acquaintance with scientific literature, his affection for all among his friends and pupils who manifested a sincere interest in his favourite studies. When, in after life, their fates scattered them far and wide over the world; some settling amid the civilised obscurity of rural seclusion; some rambling to the far ends of the earth to sift and explore wild and savage regions; some plunging into the boiling and noisy whirlpool of metropolitan activity; none who remained constant to the beautiful studies of his pupilhood was ever forgotten by the kind and wise philosopher, whose quick and cheering perception of early merit had perpetuated tastes that might have speedily perished if unobserved and unencouraged. The value of professional worth should chiefly be estimated by the number and excellence of disciples. A large share of the best naturalists of the day received their first instruction in the science, that was afterwards to prove their fountain of honour, from Professor

Jameson. Not even his own famous master, the eloquent and illustrious Werner, could equal him in this genesis of investigators. Under his auspices, too, were lasting friendships and unions of kindred minds formed, that have been productive in good to the cause of knowledge. Valuable as were his writings, each, when estimated with regard to the position of science at the time of its issue, an effective advance—his pupils were even more valuable. The greatest praise of a great professor is that which proclaims he has founded a school. And where else in the British Empire, except here, has there been for the last half century a school of Natural History ?"

Jameson attained the age of eighty years, and had filled his chair for upwards of half a century, and had done more than can now be well estimated, by his unwearied exertions. The many thousand difficulties he had to conquer, in a department of science which, at the commencement of his labours, was in its infancy, and involved in a labyrinth of vague conjectures, required a mind of a constant and steady determination to group together all the known facts, and to draw deductions from those to overturn erroneous doctrines then in existence, and to open up the path to truth.

Jameson died on the 19th of April 1854, at his residence in this city. His health in general throughout life was good, and although slender in body, he could undergo a great deal of fatigue without injuring his health. During the last two years of his life he had suffered from repeated attacks of bronchitis, which had much impaired his iron frame ; but by the judicious advice of his medical attendants, and the tender care of an afflicted and watchful family, his latter days were soothed and prolonged. He knew well that the end of his earthly existence was not far distant, and talked of it with the same calmness and composure as he did of the daily events of life. He wound up all his thoughts, in so far as they were connected with this earth, in the most perfect composure ; and, like a traveller whose toil is over, slept the sleep of the just, calm and tranquil.

On the morning of the day of his death I saw no unusual symptoms. He had passed a quiet night ; breakfasted at his usual hour; dressed, and walked to his easy-chair with a little assistance. He took luncheon, and apparently with an appetite. About mid-day he complained of slight faintness and sickness. I gave him a little wine, which refreshed him much. At 2 P.M. he again complained of sickness and uneasiness. I now asked him if he wished to go to bed; and his answer was, Yes, in a decided and firm tone. We undressed him without any difficulty; he walked from his chair to his bed, but then asked to be lifted into it, as the sickness was increasing. He lay perfectly quiet until about half-past 3 P.M., when he was seized with a shortness of breathing. Dr Alison, Dr James Wood, and Dr Newbigging, were sent for, who appeared very shortly. On examination they found their patient labouring under no immediate symptoms of apparent danger; he still lay calm and quiet, the breathing more rapid than natural. Shortly after this the features changed, and marked symptoms of sinking presented themselves; the breathing became slower and softer, and then ceased without a trace of bodily movement. He expired so quietly that those around him did not discern the final expiration,—the passing from life to death being so perfectly tranquil.

Jameson was greatly esteemed by the citizens of Edinburgh, not only as a man celebrated and highly distinguished in natural science, but of sterling worth; and to shew their sense of his merits, they awarded him a public funeral. The funeral took place on Friday the 28th April 1854, at 2 o'clock. The remains of the deceased were transferred from his house, Royal Circus, to the Warriston Cemetery. The procession began to move at half-past two, and was arranged as follows:—Police officers, Ushers, Students, Royal Scottish Society of Arts, Royal Academy, Royal Physical Society, Wernerian Society, Antiquarian Society, Royal Society, Royal College of Surgeons, Royal College of Physicians, Senatus Academicus, The Lord Provost, Magistrates, and Council—Mutes—Batonmen—the Coffin — Chief mourners — Private friends.

The late Professor Jameson was third son of Thomas Jameson, Esq., and was born at Leith on the 11th July 1774.

He was at the usual period sent to the grammar-school, then taught by Mr Wilson, where he made such progress as boys make who have no particular love for letters. Whilst at school he early shewed a strong desire of becoming acquainted with the history of natural objects; and at this period he had commenced stuffing birds shot for him by a young man, who thought himself well paid by receiving powder and shot for his labour; at the same time he was himself collecting such animals and plants as could be found on the beach at Leith and the neighbourhood. Mr Jameson entered the humanity class in the year 1788; and whilst attending this class, he walked in the procession at the laying of the foundation-stone of the New College Buildings, in one of the class-rooms of which he was destined to be a distinguished Lecturer.

The development of man's ruling propensity may in general be discovered by a careful observation of the companions and pastimes of the young. The ruling propensity may be dormant, for there may be nothing peculiarly fitted to call it into action; but when such objects as are adapted to that predisposition are brought to bear on the mind, the predisposition begins to develop itself. This was the case with the subject of this memoir. During the early period of Professor Jameson's life, De Foe's "Robinson Crusoe" was a leading book with boys; with our young naturalist it became a second life. The wonders of Crusoe's island, its birds and beasts, its inhabitants, and the situation of poor Friday, increased his desire to know more of nature. "Cook's Voyage," so interesting and instructive, and at this period universally read, increased his desire to study nature in all her grandeur and variety,—to investigate the great laws by which varied objects of interest are scattered over the surface of the globe, and ultimately to promote human happiness. The strange and romantic adventures of Peter Wilkins were not without their influence in urging the turning-point of Professor Jameson's life. Jameson used to boast that the "History of the Three Hundred Animals" *made him a Professor of Natural History.* This kind of reading gave him a strong desire to examine not only his native, but foreign lands. Whilst under the tuition of Mr Wilson, there seemed very little to excite his attention. He was a notorious truant, so much so, that one of his father's servants had more than once to accompany take him by force to the High School; and at that very time he would have spent hours reading the *Three Hundred Animals*, pursuing insects, or collecting the mollusca and zoophytes on the sea-beach. His heart was not in "*Amo*," but in Nature's glorious works.

He intimated to his father his desire to enter on the profession of a mariner—and in this determination he was guided more by his ruling desire to study nature, than by any love for a mariner's life; but to this his father objected; still the son was determined, and the good-tempered parent in time yielded to his son's wish, and apparently did not try to thwart him. Man advises, but God determines. There is a turning point in human life, and here it was exhibited; "Our times are in His hand." Some valued friends suggested to the young mariner that he might see the world, and the fulness thereof, by devoting himself to the study of the structure of man and animals, in health and in sickness, and so pressed on him the duty of yielding to his indulgent parent, by adopting the study of Medicine as a profession, in which he might still carry out his idea of the happiness of understanding the works of nature's God. He at last yielded, the maritime life was dispensed with, and he was appointed assistant to the late John Cheyne, Esq., surgeon in Leith,—and was a fellow associate with Dr Anderson of Leith, translator of Von Buch's Mineralogical Description of the Environs of Landeck, and Werner's Theory of the Formation of Veins.

Mr Jameson thus commenced a study not congenial to his taste, and a surgeon's assistant was not the best position to reconcile him to his situation.

At this period of his life, 1792, he had become acquainted with Dr Walker, then Professor of Natural History in the College of Edinburgh, under whom he commenced his hard study of nature. He attended one course of his lectures on Natural History in 1792; another in 1793. He soon became a favourite pupil, and shortly afterwards the charge of the museum was committed to him. At times when his duties permitted, he, accompanied by the Doctor himself, went on several dredging expeditions down the Frith of Forth, and often was very successful in obtaining valuable zoological treasures. We add a few of these, taken from his note-book, dated 1794: *Tritonia papillosa*, Bosc.; *T. verrucosa*, Bosc.; *Doris argo*, Lin.; *Ascidia rustica, et A. prunium*, Muller; *A. Conchilega*, M.; *Mammaria mammela*, M.; *Lineus longissimus; Nereis mollis*, Müller; *N. lamelligera; Aphrodita scabra*, Lin.; *A. aculeata*, L.; *A. punctata*, Bosc.; *A. imbricata; Amphitrite ventilabrum*, Müller; *A. cristata*, M.; *Actinia rufa; A. crassicornis; A. gemmacea*, Ellis; *Echinus lacunosus*, Lin.; *Asterias papposa*, Lin.; *A. rubens*, Lin.; *A. equestris*, Lin.; *A. glacialis; A. sphærulata*, Lin.; *A. ophiura*, Lin.; *Millepora pumicosa; C. ellepora pumicosa; Gorgonia flabellum; Spongia tomentosa; S. stuposa; Alcyonium schlosseri; A. gelatinosum; A. digitatum; Flustra foliacea; F. truncata; F. pilosa; F. carbasea; F. arenosa? F. hispida; Tubularia indivisa; T. ramosa; Corallina officinalis; Sertularia rosacea; S. pumila; S. operculata; S. abietina; S. cupressoides; S. cupressina; S. argentea; S. rugosa; S. volubilis; S. halecina; S. thuya; S. falcata; S. antennina; S. cuscata; S. filicula; S. muricata; S. uva; S. lendigera; S. geniculata; S. dichotoma; S. spinosa; S. setacea; S. polyzonias; S. loriculata; S. fastigata; S. avicularia; S. cruposa; S. ciliata; S. eburnea; S. nigra; Pennatula phosphorea; Hydra lutea?* Bosc.

Whilst attending Dr Walker, he commenced the study of an important branch of Natural History—Botany, and pursued this study with zeal and success. At this period Mr Jameson became the friend of the late Dr Anderson, who had started a periodical named the *Bee*, in which he first submitted his ideas as a mineralogist to the public. In vol. xiii. the first part of an Essay on Gems appeared, which was carried on throughout the volume. These papers were collected, and are preserved in the Professor's library, as the first fruit of the industry by which in after life he attained high eminence as a mineralogist.

In the year 1793 he visited London, where he was introduced to the principal scientific gentlemen of the metropolis.

He ever spoke of the pleasure and benefit he derived from the meetings he had with Sir Joseph Banks, Mr Diyander, Dr Shaw, and the other leading members of the Linnæan Society. After inspecting and making himself fully acquainted with the mineral and zoological collections —the Botanic Gardens, and the Leverian Museum, &c., he returned to Scotland, deeply sensible of the very kind manner in which he had been received, and the friendships he had formed, which, in many individuals, only terminated at death. On returning to Leith, he seems to have abandoned his medical engagements and turned his attention principally to Natural History, leaving the practice of medicine to his successor in the surgery. Though he resigned his surgical appointment, he did not desert those studies connected with the medical profession, because at this period he applied all the time he could spare to practical anatomy, under the celebrated lecturer John Bell, when he formed a friendship with Mr Charles (afterwards Sir Charles) Bell, with whom he dissected for a long period, to enlarge his views of comparative anatomy. Whilst Mr Jameson was dissecting, and at the same time extending his knowledge of ornithology and entomology, Mr Patrick (afterwards Sir Patrick) Walker, united with him in prosecuting these branches of science. Mr Jameson had full advantage of Mr Walker's entomological collection of native specimens, inferior only to that of Professor Walker, which at that time was considered the best Scottish collection extant. Whilst attending the chemical class, his assiduity attracted the attention of the late Dr Rotheram, then Dr Black's assistant, and afterwards Professor of Physics in St Andrews. Mr Jameson now added to his chemical knowledge, mineralogical information generally, and especially in the analytical chemistry, a branch of science which Dr Rotheram had studied in Germany; and perhaps Mr Jameson's intense desire to visit the German mines may, in a great degree, be attributed to the intimacy which subsisted between him and Dr Rotheram. This close intimacy between Rotheram and Jameson was broken off when the former retired to St Andrews, on Dr Hope being appointed to the chemical chair. Between Hope and Jameson, though opponents as geologists, friendship long subsisted. Dr Hope displayed the first oxyhydrogen blowpipe, which was constructed under Mr Jameson's superintendence—an instrument indispensable in analytical mineralogy. Thus attending lectures, and studying the subjects lectured on, he did not consider these all that were necessary to form a chemist; he felt unless he could handle a crucible as well as name it—unless he could collect the gases as well as describe them—he was only a nominal chemist. His father, entering into his views, assigned him a suitable room for his laboratory, and fully supplied him with what apparatus it required, and allowed him necessary attendants in assisting him in his experiments.

Before Jameson laid before the public any separate works, he appears to have confined his literary labours to the communication of papers on various scientific subjects which he read to the Natural History Society—a society that appears to have been instituted in 1790, but whose proceedings were not published,—and to several periodical publications. A list of a few of these papers will shew how he was occupied from the time he commenced his Natural History investigations, and how he continued to follow up these researches.

Natural History Society.

Before this Society he appears to have read the following communications:—

1. Description of the Phasianus Argus.
2. Psittacus Magnificus, Shaw.
3. On the Class Vermes, containing a Catalogue, with descriptions of most bodies of this class, as found on the Leith shore.
4. An account of Marine bodies found near Queensferry.
5. A description of the Psittacus Xanthocaudatus.
6. Description of Marine bodies found in Shetland.
7. A Catalogue of Birds found in the neighbourhood of Leith, with a few general remarks on them.
8. On the Hydra Squammata of Müller.
9. An examination of Mr Townson's description of Arthur's Seat.
10. Mineralogical Observations made in the Highlands in 1796.
11. Geological and Mineralogical Description of the Shetland Islands. Mineralogy of the Mainland—Yell—Fetlar—Balta.

12. Mineralogical Description of the Islands of Foula, Papa-Stour, Valey, Muckle Rhooe, Vementry.

We now give a list of a few of the separate Papers that appeared in the periodical publications:—

Nicholson's Journal.

13. On Granite. 1802.
14. On the supposed Existence of Mechanical Deposits in Primitive Mountains. 1802.
15. On the origin of the Rocks of the Trap formation.

Thomson's Annals of Philosophy.

16. On Formations; a Paper vindicating the Geological views of Werner from an attack made upon them by the *Edinburgh Review.*
17. On the supposed Existence of Mechanical Deposits in the Primitive Mountains.
18. On the Igneous Origin of Rocks.
19. On the Old Red Sandstone.
20. On contemporaneous Masses and Veins occurring together in the same mass of Rocks.
21. On Beds and Strata—their junctions.
22. On Stratification—on Veins—on Coal.
23. On Conglomerated Rocks.
24. On the Old Red Sandstone Formation.

Wernerian Transactions.

25. On true Veins—contemporaneous Veins—on Granite—on Gneiss.
26. On the Geognosy of the Lothians.
27. On the Mineralogy of the Pentland Hills.
28. On Conglomerated or Brecciated Rocks.
29. On Porphyry.
30. Mineralogical Observations and Speculations.
31. On Contemporaneous Veins.
32. Mineralogical Queries proposed by Professor Jameson.
33. On Colouring of Geognostical Maps.
34. On the Topaz of Scotland.
35. On the Strontian Lead-Glance Formation.
36. On Cryolite.
37. Catalogue of Animals of the class Vermes, found in the Frith of Forth and other parts of Scotland.

Edinburgh Philosophical Journal.

38. Account of Rocks formed by Hot Springs, Torrents of Hot

Water, Bursting of Subterranean Lakes, Air Volcanoes, and Cold Springs.

39. On the Geognosy of the neighbourhood of Edinburgh.
40. On the Geognosy of the Cape of Good Hope.
41. On the Geognostical Relations of Granite, Quartz Rock, and Red Sandstone.
42. On the Black Lead, or Graphite of Borrodale, of Ayrshire, and Glenstrathfarran.
43. On Secondary Greenstone and Wacke.
44. On Veins which connect Mineral Beds.
45. On Trap Veins.
46. On Parry's Voyage of Discovery.
47. On the Rocky Mountain Sheep of the Americans.
48. On the King Fish.
49. On a remarkable Thunder Storm.
50. On the Horn of a Rhinoceros found in the Loch of Forfarshire.
51. On the Formation of Opal, Woodstone, and Diamond.
52. On Water as a Moving Power for Machinery.
53. Remarks on Noises that sometimes accompany the Aurora Borealis.
54. On the Irish Elk.
55. Observations on the Geology of the countries discovered by Captains Parry and Ross.
56. On the Birds of the Himalayan Mountains.
57. On a new species of Eagle.
58. On a new species of Ibis, Tanagra, and Rubecola.
59. On Fossil Bones found in New Holland.
60. Notice of the male Lophophorus Nigelli.

In 1794 Jameson went to Shetland to acquire a knowledge of the Natural History of the Shetland Islands, where he remained three months, zealously occupied in exploring their geology, mineralogy, zoology, and botany. In 1797 the young and ardent student paid his first visit to the famous island of Arran, at that time unknown to geologists; and in the following year he published his separate work, entitled "Mineralogy of the Island of Arran and the Shetland Islands, with Dissertations on Peat and Kelp;" and being the first good geological account of places and formations ever laid before the scientific reader in this country it soon became famous throughout Europe for the remarkable phenomena described in it. "Jameson's Mineralogy of Arran and the Shetland Islands, with Dissertations on Peat and

Kelp, was a highly creditable work, displaying a large share of mineralogical knowledge, obtained under circumstances that rendered its acquisition meritorious, and exhibiting an independence of intellect that renounced the theories amidst which he was educated, and became self-convinced of the important truth, that complete mineralogical knowledge is indispensable to every speculator in geology."*

Intent on following up his discoveries, in 1798 Mr Jameson, in company with his intimate friend, Charles Bell, afterwards Sir Charles Bell, the celebrated anatomist and physiologist, spent the summer months in examining the geology of the Hebrides and Western Islands. In 1799 he visited and investigated the Orkney Islands, and again turned his steps to the inexhaustible field presented by the Isle of Arran. From these diligent researches he was enabled, in 1800, to publish his "Mineralogy of the Scottish Isles," in two volumes quarto, illustrated with maps and plates. This great work contained the first sketch of the geology of the Hebrides and Orkneys; and it has served as the foundation in all the scientific accounts of these islands which have issued from the press.

Jameson left his own country for Freyberg in 1800, where he remained nearly two years, studying mineralogy and geology under the learned and famous Werner. He worked in the mines there under the rules laid down by his master, and went through the same drudgery and the same kind of work as the common miner, by which means he acquired much valuable knowledge. Some of his companions who studied at the same time under Werner gained a high European reputation, among these were, Frederick Mohs, the celebrated mineralogist; T. F. D'Aubisson de Voisins, distinguished for his work on the Mines of Freyberg, his excellent System of Geognosy; and Basalts of Saxony;† and Professor Steffens, one of the most elegant scientific writers. How truly did Jameson delight in speaking of Steffens as a man—he spoke of the power he had in converting all his scientific pictures into poetical ones. The following short extracts from his well-known work, which we have often heard Jameson speak of with delight, shew his graphic power :—

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* Edinburgh Review.

† This work was translated by Professor Jameson's attached friend, the late Dr Neill. Jameson relied much on the judgment of Neill, and considered him a wise counsellor.—EDIT.

"*A Midnight Scene on the Ocean.*—'Once more,' says Steffens, 'let us rock our imaginations on the bosom of the deep, before we go back to the world of men and things.' We know of few attempts in prose or verse to describe the undescribable, the awful majesty, and the profound, mysterious attraction of the ocean, equal to the following. Our author was good-naturedly invited by a party of six fishermen to accompany them on an expedition to a sand-bank, at a distance of six or seven Norwegian miles from shore, where they were to pass the night. They sailed in a serene and beautiful morning: the wind afterwards rose, and the sea was agitated.

"'The night I passed there I shall never forget. As twilight closed around us on the tossing waves, we became more and more silent; the masts were lowered; the fishermen were contented with their day's work, and I now threw out my net once more; the kind-hearted fellows pressed round me with friendly curiosity as I emptied my rich booty into the tub and began to examine it. I had to give a popular lecture on the new and rare productions I had caught. Meanwhile, though the sun had sunk below the horizon, the bright evening red remained visible the whole night in the far west, and played on the waves around us—now gleaming, and then vanishing like a soft lightning. The oars lay still; the boat, left to itself, rocked on the waves; the conversation fell into monosyllables; my companions sung a hymn; I heard the murmur of their prayers, and then each, folding himself in his cloak, lay down to sleep; they slept the deep sleep of tired men. The billows dashed against the boat, and the night-air closed over our heads; the consciousness that a fathomless abyss might at any moment swallow up our small bark kept me awake, and the power of the wondrous ocean

—Solitude took possession of me. It was as if I belonged to the deep whose inhabitants I had disturbed with my daring curiosity. The dim horizon of my precarious future—a thousand pictures of the past, appeared and vanished again. Neither sorrow nor joy could assume a distinct form; all feelings blunted each other—all images rocked like the boat, and melted into each other like the waves; it was a feeling such as I never experienced before or since. In the twilight, I could not discern the distant shore; and here I learned the deep, unfathomable might with which Nature rules the soul —here, as in no other situation. By degrees all images became dimmer and more shadowy—the rocking motion of my thoughts more tranquil, gentle, and calm; the plashing of the waves sounded like a lullaby, and I sank, like my comrades, into a deep sleep.' "*

Jameson fully acknowledged that it was from Werner we first derived clear and distinct views of the structure and classification of rocks. "We are chiefly indebted to the reports of Werner's pupils," says Conybeare, "especially to those of Jameson, for our knowledge of Werner's general views, so fully developed in his lectures, and there only." And Conybeare further states, that Jameson first divulged to this country that the various species of organic remains grouped together in the rock formations, determined the age of the formations, and were of the utmost importance in a practical point of view. "Werner taught," says Jameson, "that mineralogical and geological characters, and characters derived from organic remains, were to be employed in determining formations, and that probably the same general geological arrangements would be found to prevail throughout the earth. But, he added, the truth or falsity of this view in regard to the similarity of formations can only be determined by the united labours of geologists, continued for a long series of years. He attached much importance to the mineralogical and geological characters; and in this he was right, notwithstanding all that has been said to the contrary. What are modern geologists at this moment doing, but following out the Wernerian mode of investigation, and Werner's views in regard to the universality of formations. Do not geologists in Britain determine the characters of formations according to the Wernerian School; and is this also not the case on the continent? Are not the geologists of England endeavouring to identify the formations of our island with those of Germany, France, and Italy? Are not the Americans doing the same? And do we not find geologists tracing our old red sandstones, coal formations, lias, oolites, &c., throughout India? What is this but attempting to prove the universality of formations?"

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* Steffen in his "Was ich erlebte."

Under the shelter, says Werner, of these limestone ridges which intersect Italy and Greece—ridges of all heights, ramified in all directions, and which abound in springs, separated by charming valleys, rich in the productions of living nature—philosophy and the arts first sprang to life. It is there that those minds have arisen, of which the human race has most reason to be proud of; while the vast deserts of Tartary and Africa have always been inhabited by fierce and wandering shepherds; and even in countries where they have the same laws, and the same language, a practised traveller is able from the manners of the people, from the appearance of their houses and their clothes, to guess at the composition of the soil of each canton. In the same manner as from this composition, the philosophical mineralogist conjectures what may be their manners, their degrees of comfort and of instruction. Our granite districts produce, upon all the arts of life, very different effects from our calcareous. The natives of the Limousin, or of Lower Brittany, are not lodged, they are not fed, we might even say they do not think, like those of Champagne or Normandy. Even the results of the conscription have been different, and different according to a fixed law in the different districts. Geographical mineralogy thus assumes a high importance, when we connect it with what Werner called economical mineralogy, or the history of the employment of minerals to the wants of man.

The comprehensive mind of Werner seized equally all these relations, and it was with an ever new delight, that his hearers listened to his exposition of so much of them as his public prelections embraced. But in his private conversations, he traced their application a great deal further. The history of nations, and that of their languages, was connected, in his apprehension, with that of minerals and geological formations, and he never considered himself as departing from his principal object, when he gave himself up occasionally to those other inquiries. He traced the various tribes in their migrations, according to the declivities and directions of countries, and he thus connected their progress and their stations with the structure of the globe. He connected the different languages with families; he traced each family to a common source, originating always in the most elevated point of a mountain chain; from that point he considered every dialect as descending, dividing itself according to the directions of the valleys, becoming soft or hard according as it became stationary, in a level or in a mountainous district, separating itself in process of time from the neighbouring dialects, and becoming always so much the more distinct, as the natural obstacles to communication became more insurmountable.

He endeavoured even to trace the laws of military art by those of geology; and if he had been to be believed, all generals should have begun by studying some time at Freyberg. Strangers who happened to be at Freyberg, and who expected only to converse with a mineralogist, were astonished at his continual discussions respecting tactics, politics, and medicine. Many individuals, who afterwards became great mineralogists, had only wished to hear him, that they might give a summary idea of the science of minerals; but having once listened to him, that science became the profession of their lives.

It is to this irresistible influence, that the scientific world has been indebted for these discoveries and observations which have rendered the names of Jameson, Humboldt, Buch, and, in fact, of many other geologists, renowned through Europe.

Few teachers have enjoyed this pure and unreserved gratitude to the same degree; but perhaps no one ever better deserved it by his paternal feelings. He grudged nothing to the good of his scholars,—his time, his exertions, was at their disposal. If he knew of any of them that were in occasional need, his purse was open to them. His conversation was always that of a man of genius, as well as that of a man of kind feelings. During whole hours, he would develop the boldest and best connected ideas; but it was impossible to make him take up his pen. His life was passed either in the elevated regions of contemplation, or in philosophical or friendly conversation.

"I cordially agree with Werner in opinion (says Jameson, in a paper written in 1813), that Conchology is a branch of Natural History which cannot be sufficiently recommended to the attention of all Geognosts, as furnishing important means of ascertaining with accuracy many of the leading facts in the history of the globe. It is a branch of natural history which has been long studied in Germany and France, and has of late years, particularly since its importance in geognosy has been ascertained and pointed out, made great advances. But we naturally enquire, to whom are we indebted for our present highly interesting views of the natural history of fossil organic remains in general? It is to Werner. More than thirty years ago" [now upwards of seventy years] "he first embodied all that was known of fossils into a regular system. He insisted on the necessity of every geognostical cabinet containing an extensive collection not only of shells, but of the various productions of the class zoophyta, of plants, particularly of sea and marsh plants, and ferns; and an examination of the remains of quadrupeds in the great limestone caves in Germany, soon pointed out to him the necessity of attaching to the geognostical cabinet also one of comparative osteology. As his views in geognosy enlarged, he saw more and more the value of a close and deep study of fossils. He first made the highly important observation, that different formations would be discriminated by the organic remains they contained. It was during the course of his geognostical investigations that he ascertained the general distribution of organic remains in the crust of the earth. He found that fossils appeared first in transition rocks.* These are but few in number, and confined to molluscs and zoophytes. In the older flötz rocks they are of more perfect animals; and in the newest flötz* and alluvial rocks, of birds and quadrupeds, or animals of the most perfect kinds. He also found that the oldest vegetable petrifactions were of marine plants, the newer of large trees. A careful study of the genera and species of petrifactions disclosed to him another important fact, viz., that the fossils contained in the oldest rocks are very different from any of the genera or species of the present time; that the newer the formation the more do the remains approach in form to the organic beings of the present creation, and that in the very newest formations fossil remains of the present existing species occur. He also ascertained that the fossils in the oldest rocks were much more mineralised than the petrifactions in the newer rocks, and that in the newest rocks they were merely bleached or calcined. He found that some species of fossils were confined to particular beds, others were distributed throughout whole formations, and others seemed to occur in several different formations; the original species found in these formations appearing to have been so constituted as to live through a variety of changes which had destroyed thousands of other species, which he found confined to particular beds. He ascertained the existence of fresh water shells in solid strata, sometimes alone, sometimes intermixed with marine productions. These highly interesting observations having become generally known by means of his pupils, gave a stimulus to the study of fossils, which in a few years produced important results. They attracted the particular attention of the mineralogist, and roused the curiosity of the zoologist and botanist, who saw land before them,—a wide field of the most interesting nature. The mineralogist confidently anticipated from this study important elucidations in regard to the various changes the earth had undergone, dur-

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* Now the Cambrian and Silurian. The learned and elaborate works of

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Sedgwick and Murchison mark the commencement of a new era in those geological studies which relate to what had been called, until then, the Transition or Greywacke formation. Jameson was of opinion that the true Cambrian system existed highly developed in many parts of Scotland.—EDIT.

* In the district which Werner first investigated, the primitive and transition strata were highly inclined, while the secondary of Lehman were horizontal. To these latter he (Lehman) gave the name of flötz.—EDIT.

ing the progress of its formation, from the earliest periods to the present time. The zoologist and botanist, by the discovery of new genera and species, hoped to increase the number of natural families, to fill up gaps in the present systems, and thus to perfect more and more the natural system of animals and plants. But this was not all. The philosophic naturalist soon saw that these investigations would also lead to much curious information in regard to the former physical and geographical distribution of plants and animals, to the changes which the animated world in general, and particular genera and species, have undergone, and probably are still undergoing; and he would naturally be led to speculate on the changes that must have taken place in the climate of the globe during these various changes and revolutions. The writings of Blumenbach, Von Hoff, Cuvier, Brongniart, Steffens, and other naturalists, are proofs of what has been done by following up the views of Werner."*

"In our last number (says Thomson), we inserted an admirable paper by Professor Jameson, of Edinburgh, vindicating the geognosy of Werner from the attack made upon it by the *Edinburgh Review*. Professor Jameson maintained, against the opinion of the reviewer, that Haüy and Brongniart, in their account of the environs of Paris, had adopted the conclusions, and used the language, of the Wernerian geognosy. Had he seen the *Recherches sur les Ossemens fossiles de Quadrupeds*, published by Haüy in 1812, he would have found the following passage, which deserves to be quoted as a vindication, or rather demonstration, of Professor Jameson's opinion:—'En effet, la partie purement minerale du grand probleme de la theorie de la terre à été etudiée avec un soin admirable par de Saussure, et portée depuis à un developpement etonnant par M. Werner et par les nombreux et savans eleves qu'il à formés—Le second (Werner) profitant des nombreuses excavations faites dans le pays du monde ou sont les plus anciennes mines, à fixé les loix de succession des couches; il à montré leur ancienneté respective et pursuivi chacune d'elles dans toutes ses metamorphoses. C'est de lui, et de lui seulement, que datera la geologie positive, en ce qui concerne la nature minerale des couches ; mais ni l'un ni l'autre n'a donné à la determination des especes organisées fossiles, dans chaque genre de couche, la rigueur devenue necessaire, depuis que les animaux connus s'elevent à un nombre si prodigieux.'" Tome i., p. 34.

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* The genius of Werner, of De Saussure, and of Cuvier, laid the foundations on which geology now rests. They gave us the first glimpse of the fauna and flora of the earlier ages of our planet.—Edit.

Mr Jameson returned to his native land in 1804, being recalled in consequence of the state of his father's health. The knowledge of rocks and minerals he had acquired under the tuition of Werner proved of the utmost importance to him, and such knowledge no one possessed in this country but himself, which he subsequently greatly improved and extended. It appears to have been his full intention to have returned to Freyberg again, because in writing to his friend Meuder, he says: "My dear Friend, I received your most agreeable and kind letter on the 1st day of February. It would have reached me sooner, but the intense frost prevented the packets from getting to England until late in the month of January. I return you a thousand thanks for the information you have had the goodness to communicate to me. I am much gratified by Werner's kindness. There is nothing I desire so much as again to visit Freyberg ; and I seriously intend, on the very first opportunity, to visit Germany. At present, I am so situated that I cannot undertake any journey for at least twelve months ; after that period I hope to be able to pay a visit to Freyberg." The indisposition of Dr Walker caused Jameson to lay aside all notions of paying a second visit to Germany. On the death of Dr Walker, in 1804, Jameson was appointed Professor of Natural History ; and by his publications and admirable lectures, he soon raised the Edinburgh School to a high degree of celebrity.

Dr Walker was profound and learned in classical literature. While engaged in preparatory labours, about the year 1750, his attention was attracted by the museum of Sir Andrew Balfour, the sight of which first inspired him with an attachment to natural history that operated powerfully on his mind and future pursuits, and which he never lost. After his death, a volume of Tracts was published, which, together with his "Travels," and his Essays in the Royal Transactions, are all that remain to keep alive his remembrance. His lectures were much esteemed for the clear and scientific manner in which they were written. "The appointment of Professor Jameson, the favourite pupil of Dr Walker, to be his successor in the chair, in 1804," says his highly distinguished and true friend, Dr Fleming, "raised great expectations, and were speedily realized. The notions of the Huttonians, at this period, respecting the laws of superposition of the strata were very defective, scarcely amounting to perceivable glimmerings. But Professor Jameson, intimately acquainted with the geognosy of Werner, speedily began to group the rocks of the neighbourhood into their distinct formations, and to assign the relative position of our transition rocks, old red sandstone, and the independent coal formation. This important step in the progress of our geology was followed by a system of prelections, accompanied by excursions to the more important localities, where the phenomena could be studied in the field, and produced a number of zealous observers, who have not only extended our knowledge of the structure and contents of this locality, but of the United Kingdom and its dependencies." Fleming, one of the very few remaining of the Wernerians of Jameson's standing, did more good to his country in forwarding the correct method in describing natural bodies, in his work on the Philosophy of Zoology, than any man living at that time. This work will always be highly appreciated as a standard work of reference. The extent of Jameson's lectures on Natural History, which embraced general views and particular details in Meteorology, Hydrology, Mineralogy, Geology, Botany, and Zoology, will be seen from the following condensed and short outline of them.

METEOROLOGY.

1. *General Properties of the Atmosphere.*—Pressure—Figure—Height—Temperature—Colour—Light—Transparency—Refraction and Twilight—Temperature of Space—Transparency of Space—Composition.

2. *Aqueous Meteors.* — Evaporation — Dew — Hoarfrost — Aqueous Fog—Dry Fog—Clouds—Rain—Hail—Sleet—Snow—Snow line—Glaciers—Avalanche—Iceberg.

3. *Luminous Meteors.*—Rainbow—Halo—Parhelion and Paraselene—Corona—Shadows—Unusual Atmospheric Refractions—Atmospherical Electricity—Fireballs—Falling or Shooting Stars—Aurora Borealis—Zodiacal Light.

4. *Winds.*—Force—Velocity—Direction.

5. *Sound.*—Different kinds—Propagation—Intensity—Velocity—Transmission—Reflection—Echoes—Physical and Moral Effects on Man.

6. *Atmospheric Zoology and Botany.*—Characteristics of Atmospheric Animals and Plants, as determined by the Microscope—Connection of their Organism with the Healthiness of Places—their Geographical Distribution.

7. *Prognostics of the Weather.*—From the Sun—Moon—Stars—Atmosphere—Ocean—Lakes— Springs— Animals— Plants and Minerals.

8. *Meteorological Instruments.* — Barometer — Thermometer—Actinometer—Cyanometer—Electrometer—Rain Gauge—Anemometer—Vane—Magnetic Needle—Professor Leslie's Meteorological Instruments.

9. *Climate.*—Physical Seasons—Climate in General—its Different Kinds—Climate from the earliest Historic Time—the present Climate of the Globe—Climate of Great Britain—Subterranean and Submarine Atmospheres.

10. Ancient or Geological Meteorology.

HYDROLOGY.

1. *Water.*—Colour— Form— Distribution— Importance in the Economy of Nature and to Mankind.

2. *Ocean.*—Level— Colour—Transparency—Temperature—Depth—Air in Sea Water at different depths—Visibility of Shoals—Composition— Sea Ice—its Mineralogical and Geological Characters—Luminousness—Motions—Waves—Currents—Gulf Stream—Whirlpools—Tides, their Phenomena and History—Propagation by Sound in Water—Vision under Water—Oceanic Scenery and Climate—Oceanic Terraces.

3. *Springs*—Different kinds of Springs—Magnitude—Temperature—Colour—Composition—Rocks formedby Springs during different periods of the Earth's Formation—Influence of Earthquakes on Springs — Geognostical Situation — Geographical Distribution—Theory of Springs—Artesian Wells—Uses to Mankind in the Economy of Nature.

Lakes.—Different kinds of Lakes—Situation—Distribution—Number—Magnitude—Depth—Temperature—Colour—Occultation—Agitations and the Rise and Fall of the Waters of Lakes—Floating Islands in Lakes—Lake Noises—Water of Lakes—Formation of Lakes—Theory of Lakes—Lake Scenery and Climate.

5. *Rivers*—Different Classes—River Districts—Direction—Fall—Velocity—Eddies—Retardation—Drying up or Desiccation—Occultation—Colour—Temperature—Effect of the clearing of Land on the Running Water of a Country—River Ice—Beds of Rivers and the Materials they carry along with them—Quantity of Sediment—Rise of the Bottom—Inundations—Magnitude—Deltas—Bars at the

mouths of Rivers—Cascades—Water—its Varieties and Composition—River Terraces—River Scenery and Climate.

MINERALOGY.

Preparative Part of Mineralogy.—Physical Properties of Mineralogy—Morphological Characters of Minerals—Systematic Arrangement of Minerals—A System founded partly on External and partly on Chemical Characters adopted.—In this system there are three Classes; — Class 1. *Acrogenous*—On Surface-formed Minerals—Gases—Waters—Acids, and Salts. Class 2. *Geogenous,* or Minerals of which the known Solid Part of the Earth is chiefly composed—divided into Haloidal Minerals or Tasteless compounds of Earth and Acids, and Tasteless Compounds of Metals and Acids; Terrigenous or Earthy Minerals—Metalliferous Minerals. Class 3. *Phytogenous Minerals*—Minerals chiefly formed of Mineralized Vegetable Matters.

Descriptions of Simple Minerals—Uses of Simple Minerals in the Arts—Medicine—Agriculture—and in the Economy of Nature, Physical and Geographical—Distribution of Simple Minerals.

GEOLOGY.

Cosmical Properties of the Earth.—Figure; Magnitude; Density; Electricity; Magnetism; Luminousness; Temperature; Volcanism, including Earthquakes, Volcanoes; permanent upraising and subsidence of the Land; Theory of Earthquakes and of Volcanic Eruptions; and Account of Salses, Gas Springs, and Hot Springs.

Morphology or Physiognomy of the Earth, including descriptions of Continents, Islands, Peninsulas, High Lands, and Low Lands; Plains, including Landes, Steppes, Deserts, Llanos, Selvas, Pampas, and Oases; Mountains, including Single Mountains, Chains of Mountains, Groups of Chains of Mountains, Chains of Groups of Mountains, Hilly Land; Valleys; Caves, Caverns; inequalities of the Submarine land.

Structures observable in the Solid Mass of the Earth.—Structure in general; structure of Mountain-Rocks, Mountain Masses, Mountain Groups, and Crust of the Earth; uses of the Compass and Quadrant explained.

Known thickness of the Crust of the Earth.

Materials of which the Earth is chiefly composed, as Water, Silica, Alumina, Rocks, Quartz, Felspar, Mica, Hornblende, Limestone, Gypsum, and Coal.

Petrography or description of the different kinds of Rocks, according to *Composition and Structure.* Crystalline Rocks. Siliceous Rocks. Silicate Rocks. Haloidal Rocks. Mechanical or Conglomerated Rocks, &c. Zoogenous Rocks. Phytogenous Rocks, Clays, Sands, &c.

Rocks, as to modes of Formation, viz., Plutonian, Metamorphic, Neptunian, Volcanic, and Contemporaneous.

Rocks according to Position, viz., Primary, or Azoic, Transition, or Palæozoic, Secondary, Tertiary, Alluvial, Volcanic.

General Palæontology. Formation of Mountains, Valleys, Plains, and Caves.

Geognostical Groups of different Countries compared as to magnitude. Theories of the Earth. Hutton, Werner, &c. &c.

Soils — their Physical and Chemical Characters; Description and Arrangement. The Connexion of Geology with Agriculture, Planting, and the Characters and Distribution of Diseases. Account of the Planetary System.

Comparison of the Form, Magnitude, Weight, Surface, Light, and Atmosphere, of the Sun, Moon, and other members of our Planetary System, with those of the Earth. Fixed Stars, as seen by the naked eye and the telescope; and the various groupings and arrangement of these, constituting the Grand System of the Universe.

Geognostical Structure of Scotland, England, and Ireland. Modes employed in searching for Useful Minerals. Mode of conducting Mineral Surveys, of constructing Geognostical Sections and Maps, and of modelling Mountains, Hills, and Plains.

BOTANY.

General account of the Structure, Physiology, and Systematic Arrangement of Plants. Physical and Geographical Distribution of Plants.

Distribution and Characters of Fossil Plants in Transition, Secondary, Tertiary, and Alluvial Formations. Comparison of the present Distribution of Plants with that exhibited by Fossil Plants. Changes in the climate of the Earth, as disclosed by the Physical and Geographical Distribution of Living and Fossil Plants. Natural History of Coal illustrated by the phenomena exhibited by Fossil Plants. Connexion of the Geography of Plants with the Political and Moral History of Man.

Influence of the Phenomena of Vegetation on the Taste and Imagination of Nations.

ZOOLOGY.

Fundamental Principles of Zoology; General Properties of Organised Bodies; General View of Homological Anatomy; Functions and Organs of Animal Life; Intelligence and Instinct; Motions of Animals; Nutrition; Circulation; Respiration; Secretion; Embryology; Peculiar Modes of Reproduction; Metamorphoses of Animals; General Geographical, Physical, and Geognostical Distribution of Animals.

MAN.

Characters by which Man is distinguished from the lower animals; Division into Male and Female, the general and particular characters of each; there is but one species of Man; The species Man is divided into Races, Sub-races, Kinds, Families, and Varieties. These defined and described; Man considered as to Colour, Stature, Size, Strength, Longevity. Geographical Distribution of Man; Physical Distribution of Man; Population of the Globe; Age of Man—1. Historically considered—2. Geologically considered.

ANIMAL KINGDOM.

VERTEBRATA (*Vertebrates*).

Characters of this Sub-Kingdom enumerated.

CLASS I. MAMMALIA.

Embryology; Characters used in the Description, Arrangement, and Determination of the Species.

Account of the Orders, viz., *Omnivora; Carnivora*; *Herbivora;* and *Cetaceà,* with the principal Genera and Species. Fossil Mammalia.

CLASS II. AVES (*Birds*).

Embryology; Characters used in the Description, Arrangement, and Determination of the Species.

Account of the Orders Accipitres—Insessores—Scansores—Gyrantes—Cursores—Grallatores—Palmipedes; with the Genera and Species, as far as is necessary for the Students. Fossil Birds.

CLASS III. REPTILIA (*Reptiles*).

Embryology; Characters used in the Description, Arrangement, and Determination of the Species.

Account of the Orders, viz., *Rhizodonta* (Rhizodonts); *Lacerta* (Lizards); *Ophidia* (Serpents); *Chelonia* (Turtles); *Batrachia* (Frogs), with the principal Genera and Species. *Exhibition of Specimens.* Fossil Reptilia.

CLASS IV. PISCES (*Fishes*).

Embryology; Characters used in the Description, Arrangement, and Determination of the Species.

Account of the Orders, viz., *Ganoidea* (Ganoids); *Placoidæa* (Placoids); *Ctenoidæa* (Ctenoids); *Cycloidæa* (Cycloids), with the principal Genera and Species.

Fossil Fishes considered.

SECOND SUB-KINGDOM.

ARTICULATA (*Articulates*).

CLASS I. INSECTA (*Insects*).

Embryology; Orders.—Coleoptera; Dermaptera; Orthoptera; Hemiptera; Neuroptera; Hymenoptera; Lepidoptera; Rhipiptera; Diptera; Syphonaptera; Parasita; Thysanoura.

ARACHNIDA (*Spiders, &c.*)

Orders.—Pulmonata; Tracheata. Fossil Arachnida.

MYRIAPODA (*Centipedes, &c.*)

Orders.—Chilopoda; Chilognatha. Fossil Myriapoda.

CLASS II. CRUSTACEA (*Crustaceans.*)

Orders.—Decapoda; Stomapoda; Amphipoda; Læmodipoda; Isopoda; Branchiopoda; Pœcilopoda; Cirrhipeda; Trilobites; Fossil Crustacea.

CLASS III. ANNELIDA (*Annelids, or Red-blooded Worms*).

Orders.—Tubicolæ; Dorsibranchia; Abranchia. *Exhibition of Specimens.* Fossil Annelida.

THIRD SUB-KINGDOM.

MOLLUSCA or CYCLOGANGLIATA (*Mollusks*).

CLASS I. CEPHALOPODA (*Cephalopods*).

Orders.—*Sepiacea*, Cuttlefish; Ammonitæ; Nautilacea. Fossil Cephalopoda.

CLASS II. GASTEROPODA (*Gasteropods. Univalves*).

Orders.—Pulmonea (*Pulmonates*); Branchifera (*Branchifers*); Pteropoda (*Pteropods*). Fossil Gasteropoda.

CLASS III. ACEPHALA (*Acephals, Bivalves*).

Orders.—Lamellibranchiates (*Lamellibrianchiats*); Brachiopoda (*Brachiopods*); Bryozoa. Fossil Acephala.

FOURTH SUB-KINGDOM.

RADIATA (*Radiates*).

CLASS I. ECHINODERMA (*Echinoderms*).

Orders.—Holothurida; Apoda; Echinida; Asterida; Crinoida. Fossil Echinoderma.

CLASS II. ACALEPHA (*Acalephs, Sea-Jellies or Medusæ*).

Orders.—Palliograda; Physograda; Ciliograda. Fossil Acalepha. *Exhibition of Specimens.*

CLASS III. POLYPIFERA (*Polyps*).

Orders.—Hydrozoa (*Hydroids*); Anthozoa; Rhizopodia (*Rhizopods*). Fossil Polypiferæ.

CLASS IV. ENTOZOA (*Intestinal or White-blooded Worms*).

Orders.—Cælelmintha (*Owen*), Vers intestinaux cavitaires (*Cuv.*), Sterelmintha (*Owen*), Vers intestinaux parenchymateux (*Cuvier*).

CLASS V. POLYGASTRICA (*Polygastrics or Animalia Infusoria, Auct*).

Orders.—Diacæla; Cylocæla; Anentera. Fossil Polygastrica.

CLASS VI. PORIPHERA, or AMORPHOZOA (*Sponges*).

Orders.—Keratosa, *with corneous spiculæ;* Leuconida, *with calcareous spiculæ;* Halinida, *with siliceous spiculæ.* Fossil Poriphera.

In the same year that Mr Jameson was appointed Professor of Natural History in the University of Edinburgh, he published his *Mineralogical Description of Scotland*, vol. i., Part 1st, in octavo, with map and plates. This volume contained an account of the Geology of the County of Dumfries, and was the first systematic, scientific description of any of the counties of Scotland. It was Jameson's intention to have published geological accounts of all the counties in Scotland. But his unwearied labours in the museum, and the publication of a System of Mineralogy, and volume on the Characters of Minerals, fully occupied all his leisure time. Both of these works were highly thought of, and ran speedily through large impressions.

In 1808, he founded at Edinburgh the Wernerian Natural History Society; a society which has eminently contributed to the great advancement which has taken place in our national cultivation of those sciences; and he was elected perpetual President,—Dr Neill being the devoted secretary* of the Wernerian Society. Seven volumes of Transactions and Memoirs have been published, to which the Professor was a frequent and efficient contributor.

In 1809, he gave the world, in one volume octavo, the "Elements of Geognosy," the whole impression of which was sold off in a few months. The doctrines of the Wernerian school were unknown to Dr Hutton; nor were they introduced effectively in England till the publication of Professor Jameson's Elements of Geognosy in 1808; the professed object of that work being to make known the view of his master respecting the composition and structure of the globe. But the Neptunian theory, as modified by Werner, was so intimately incorporated with the system, that it was scarcely practicable in discussion to separate the doctrine from the facts. The result was a division of the northern geologists of Britain into the Wernerian and Huttonian doctrines; and their warfare, though party-spirit may for a time have caused some inconvenience, was ultimately useful, by exciting attention and diffusing a taste for geology. The Wernerians had very much the advantage over most of their opponents, in their acquaintance with the character and relations of rocks. The progress, therefore, which geology for some years made under their hands, no doubt had been much more rapid, but in the theoretic trammels much incumbered them.†

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* It is much to be regretted that we have not as yet a biography of our excellent friend and highly esteemed citizen.—Edit.

† Ami Boué, in speaking of the Wernerian and Huttonian views, says: "Professor Jameson well deserves high honours conferred on him by his city and country, for the services he has rendered to science. He has spread valuable working pupils all over the world, and he was the electric spark which originated the beginning of true geology in Great Britain. The battles of his Wer-

The celebrated Mr Hopkins says, " Much has been written against the theoretical deductions of Werner; but however inconsistent they were, those which have been founded on the assumed igneous agency are much more arbitrarily drawn, most irregularly applied, and totally irreconcilable with the observed phenomena, and have tended quite as much as the dogmas of our predecessors to bring the geological science into disrepute. Indeed, the science may be considered at present as Fossil Geology, combined with Comparative Anatomy. If we refer to the descriptions of the primary rocks, we find them so imperfect and in so inapplicable to their general structure, and mixed so much with hypothetical ideas, that those who derive all their knowledge from books must imagine these rocks as confused igneous masses void of all order. Those who are practically acquainted with the subject, know that the crystalline rocks possess an harmonious symmetrical structure."

In 1813, Professor Jameson advised the translation from the German of a publication of travels through Norway and Lapland, during the years 1806, 1807, 1808, in one volume, quarto, by Baron Leopold von Buch, the distinguished traveller and geologist. This was well executed by Mr Black; and Professor Jameson added to the interest of this very valuable work, by an account of its author, and various notes illustrative of the natural history of Norway. Mr Jameson intended this volume as one of a series of translations, particularly from the German, of the travels of men who, like Von Buch, could describe the appearance and geological structure of the countries they visited, and also convey to the reader delightful pictures of the climate, state of society, and of the nature of the animal and vegetable kingdom.

In 1816, another edition of the System of Mineralogy made its appearance, in three volumes, and was for the time the most complete work extant upon the subject. A new edition of his " Characters of Minerals" was also called for at the

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nerian school with the Huttonian army was a true benefit to science—the unqualified Huttonians were shot down and only the best remained. If many fine fellows of the Wernerian school did fall also, Professor Jameson remained, and was the first to shake hands with his former enemies."

same period; and again, in 1820, other editions of both productions were demanded and produced. In these the Natural History mode and arrangement was adopted, and great improvements and additions were made. "In the spring of 1818," said the late Professor Mohs, "I had the pleasure of seeing my much respected friend, the celebrated Professor Jameson, at Edinburgh, to whom mineralogy has been so much indebted, both by his extending the knowledge of it in Great Britain, and by his exciting a general interest in it in that country where so much has already been done, and where it may be expected that in a short time so much more will be accomplished. I found him occupied with ideas respecting the Natural History of the Mineral Kingdom, which were similar to my own; and we soon came to agree with one another with regard to its most important points, because, in fact, our opinions had in a great measure coincided, before being mutually communicated."

In 1821, Jameson published a Manual of Minerals and Mountain Rocks,—a work of great value, and which was considered by all competent judges as the best text-book of its time. An edition of fifteen hundred copies was sold in the course of a few months. In 1819 he commenced the Edinburgh Philosophical Journal. For the first six years he conducted it with Sir David Brewster, but since that period he has been the sole editor. This work was planned by Brewster (now Sir David) and Jameson, at the suggestion of the late Dr Neill, and countenanced by Constable. It now extends to seventy volumes, and is, we believe, admitted to be the most valuable repository of scientific information in Britain for the period of its existence. The earlier volumes contain not a few contributions from himself; and besides numerous original articles from other hands, the Journal comprehends translations of memoirs from the French, German, Italian, and Swedish languages, with many communications from foreign correspondents on all the branches of Natural History. It will form one of the most durable monuments of his talents and industry.

Busy as his life was, and while always delivering two courses of lectures per annum (a winter and a summer one), he yet found time for extra labour in other directions. In 1813, appeared Cuvier's celebrated Discourse on the Theory of the Earth, with numerous illustrations, "translated by a gentleman," says Jameson, "well known to the philosphical world by his various useful writings, the late Mr Kerr, whom a sudden death has snatched from this transitory scene. The notes I have added, will, I trust, be found interesting; and the account of Cuvier's Geological Discoveries, which accompanies them, will be useful to those who have not an opportunity of consulting the great work." This elegant and popular volume produced an excellent effect in our country. Cuvier, with all his genius and fame, was but partially heard of in Britain till this essay appeared, and it made him more familiar to our libraries than all his own invaluable writings put together. It ran through five impressions (upwards of six thousand copies) within a very short period. Mr Kerr's translation was a work of 190 pages, but Jameson, in the 5th edition, completely remodelled the whole, and extended it to 550 pages. To the "Encyclopædia Britannica," Napier's edition, he contributed the articles Mineralogy, Geology, and Organic Remains; and to the "Edinburgh Encyclopædia," the following articles,—Adelfors, Ailsa, Alabaster, Altai, Alleghany Mountains, Amber, Ambergris, Ammoniac, Ammonites, Amphibia, Amphibious, Arran, Diamond, Hartz, Mineralogy, and the other articles in that work bearing the signature (R).

On the return of Captain Parry from his polar expedition, and at the request of that gentleman, he drew up from the specimens brought home a sketch of the geology of the different coasts discovered and touched upon by our enterprising navigator; which was published, together with the botanical observations of his friends, Brown and Hooker, and formed the scientific companion to Parry's interesting narrative. He drew up for the Cabinet Library an account of the Geology of the Arctic Regions visited by Captain Parry. He wrote excellent articles on the Physical Geography of Africa and India, which appeared in the Edinburgh Cabinet Library.

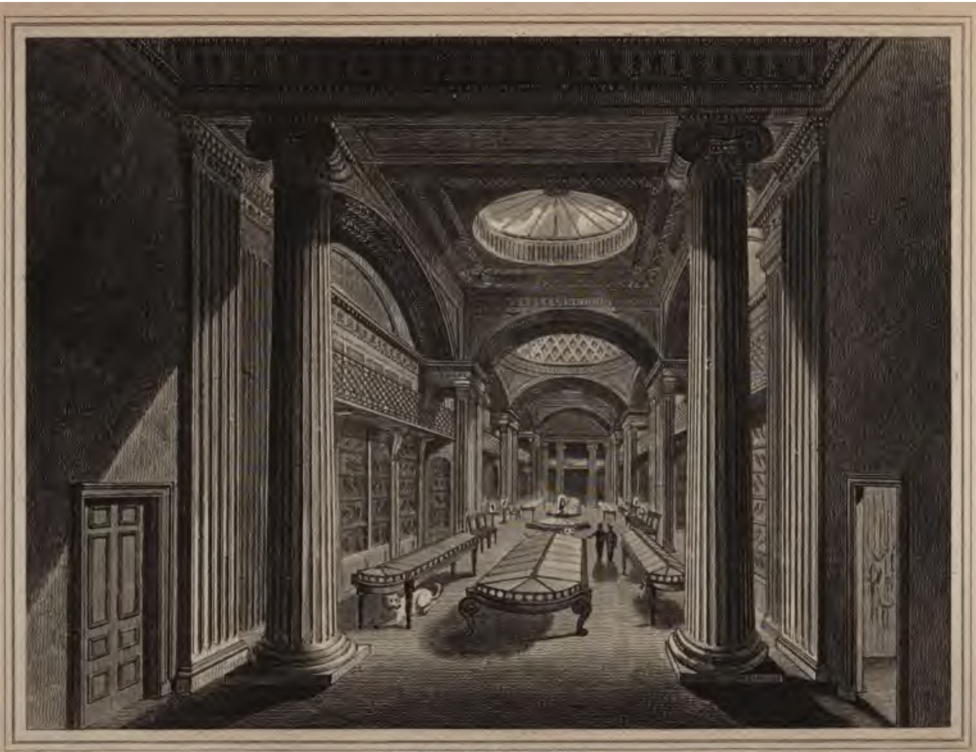
He edited an edition of Wilson's American Ornithology, which appeared in four volumes. The whole was revised and arranged in a scientific manner by Professor Jameson, and made suitable for a text-book in our universities, and also in our schools.

We have now pretty accurately enumerated the literary productions for which the public are indebted to the great talent and indefatigable industry of Professor Jameson; they are such as to reflect honour upon himself, upon his school, and his country. Many of his pupils rose to distinction. For example, Professor James Forbes, the highly distinguished and celebrated Professor of Natural Philosophy in the Edinburgh University; Professor Edward Forbes, Regius Professor of Natural History in the same university, and successor to the late Professor Jameson; Earl of Cathcart, the distinguished military and famous geologist; Charles M'Laren, Esq., our distinguished geologist; Dr Grant, zoologist and geologist, one of the first of the present day; the late Sir George Mackenzie, author of "Travels in Iceland;" the late Dr Hibbert, author of the "History of the Shetland Islands;" Professor James Nicol, Regius Professor of Natural History in the University of Aberdeen; Professor Harkness, Professor of Queen's College, Cork; Dr Fitton, late President of the Geological Society of London; Dr Richardson (now Sir John), the companion of Franklin; Mr Crawford, the author of the valuable work on the "Islands in the Indian Sea;" Dr Scoresby, the celebrated voyager, whose work on the Arctic Regions and voyage to Greenland have obtained much deserved applause; the late Dr Oudney, the African traveller, the companion of Denham, and of the Professor's friend Clapperton; the late younger Park, the son of Mungo Park, the celebrated African explorator; M. Necker de Saussure, author of the interesting "Geological Travels through Scotland," in three volumes, and of many important Memoirs published at Geneva; Dr Boué, lately President of the Geological Society of France, and one of the most distinguished living geologists; the late Dr Turner, Professor of Chemistry in University College, London, and author of the famous Text-Book on Chemistry; the late Professor MacGillvray, Regius Professor of Natural History in Aberdeen, and many others in whose welfare Jameson had taken a warm concern, and who have gone from his class-room imbued with an ardent love for those sciences in which he had been their instructor.

MUSEUM.

The first indication we have of a museum was made by Sir Andrew Balfour, who died in 1694, in the 63d year of his age, and bequeathed his extensive collection to the University of Edinburgh. The Rev. Dr John Walker, Professor of Natural History in the University of Edinburgh, in speaking of Balfour's Museum, states that it was deposited in the Hall of the College, which was afterwards the Library. It is melancholy to relate the fate of this Museum, that had cost Balfour forty years' labour, and was at the time believed to be the finest collection in Europe. It lay for many years in the University Hall, useless and neglected, some parts of it crumbling into dust and inevitable decay, and others abstracted; yet, even after the year 1750, it still contained a considerable collection. Soon after that period it was dislodged from the Hall where it had been long kept, was thrown aside, and exposed as lumber; was further and further dilapidated, and at length almost completely demolished. In the year 1782, out of its ruins and rubbish, Dr Walker extracted many specimens, still valuable and useful, and placed them in the College Museum, to remain there as precious relics of the first naturalist, and one of the best and greatest men of his time.

But the Doctor's anticipations were not destined to be realized. He had collected for the use of his class a number of specimens, which he added to the pitiful remains of Balfour, but he had not the generosity to bestow them on the public, or perhaps did not consider them worth a bequest; and at his death, the Museum, and the remains he seemed so eager to preserve, underwent a second spoliation, and the miserable fragments left were of little benefit to Jameson, his more eminent successor, who deposited in the Museum the whole of his own valuable private collection, and may now be considered the founder, as well as the builder, of that splendid Museum, which is the boast of our University, and one of the most attractive as well as important objects of



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COLLEGE MUSEUM EDINBURGH.

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curiosity in our city, and highly useful in many points of view, as a stimulant towards improvement and progress in science and art, and a source of innocent recreation for the community—a place where all may derive sound and beneficial knowledge, an access to social blessings, and a welcome relief from social miseries.

From the valuable records of the Town we learn that in 1765 the Lord Provost, Magistrates, and Council, took a deep interest in the University Natural History Museum, selected a room adjoining the Old College Buildings, fitted it up for that purpose, and voted several hundred pounds for glass cases, drawers, &c., and for purchasing and preserving specimens of natural history.

In 1785 many of the county gentlemen also took a warm interest in the formation of a Museum, and were anxious that it should be established on a firm basis, not only for the benefit of the city, but for Scotland in general. Among these we may mention the names of a party who presented six hundred specimens of Natural History to the Museum, viz., the Duke of Buccleuch, Lord Hailes, Lord Daer, Earl of Hopetoun, Bailie James Dickson, Dr Monro, Dr Cullen, Captain Cook, and others. At this period, and up to 1812, the Museum was under the patronage of the Town, and all expenses connected with it were paid out of their exchequer, and a yearly sum granted to the Professor to procure specimens.

At the death of Dr Walker the collection in the Museum was almost entirely removed by his trustees. Jameson informs the Royal Commission, in 1826, that he had no power then to interfere with that collection, as it was under the control of Walker's trustees; and on being questioned by the Royal Commission in regard to it, he says, that "the portion left for the Museum was very small, and there was now scarcely anything left, nearly the whole of the collection having been thrown out. A few things were kept for a year or two; they gradually gave way, in consequence of having been badly prepared. There are a few rocks, and articles of Indian dress which still remain, the only articles left of any consequence."

In 1812 the management of the Museum underwent a complete revision. The great increase in all the departments of Natural History now called for a much larger sum of money for its actual support than any of the authorities were willing to grant.

Professor Jameson earnestly appealed to the Crown for a grant of money for the support of the Museum. After a great deal of anxiety of mind and toil, he succeeded in obtaining £100 per annum, for expenses incurred in its preservation, and for the purchasing of specimens. At this period he shewed that the collection consisted of 2290 specimens of quadrupeds, birds, fishes, reptiles, insects, and shells, and about 19,000 specimens of minerals and rocks, the whole of which had been accumulated by his unceasing energy, and an outlay of heavy private expenses.

In 1819 the famous Dufresne collection was purchased at the recommendation of Professor Jameson. He ascertained that M. Dufresne was anxious to dispose of it to the Edinburgh University. Both the Emperor of Austria and the Emperor of Russia offered a much larger sum for it than that proposed by Jameson, but still Dufresne gave Edinburgh the preference. The labour and anxiety Jameson had in unpacking and arranging this collection for public exhibition was great. When this magnificent collection was arranged, Jameson, at the recommendation of the Town-Council and Professors, opened the great halls of the New Museum to the public, on each visitor paying two shillings and sixpence admission money. This experiment, which met with much opposition at first, turned out well, as Jameson soon became able by this means to keep the Museum open to the public, and to carry on the whole establishment in an efficient style, without incurring public debt.

In 1826 Jameson reported that he had filled with objects of Natural History the great halls and galleries of the West Museum, and five galleries of the East Museum.

In July 1834 the Town-Council reduced the fee of admission to one shilling, with the view of increasing the income. Jameson, guided by his long and unwearied experience, stanchly opposed this measure, but it was carried against him. The experiment, however, did not meet with that success which was expected, and the income of the Museum yearly diminished; the revenue, which at one time was £600 per annum, being now reduced to £130 per annum; but still all this had no effect on Jameson, which shews well his high spirit and determination, not to allow even a trace of retrogression, far less to allow his noble Museum to fall into inevitable decay for want of means and public support.

He now made another appeal to Government for an increase of allowance, and without much difficulty got the one hundred per annum raised to two hundred per annum; this, along with the scanty means he derived from the door fund, again restored matters, and allowed him to carry on the movements of the Museum up till the hour of his death, but not without great private outlay. In short, the whole comes to this, that the present Museum was founded, created, arranged, and exposed for public exhibition by the head and the industrious hands of one man—Jameson. We have still to learn what the public have to say for all this. In fact, if Jameson had received the whole amount granted by the Exchequer for his own toil and labour, he would have been, even then, ill paid. But let it be understood that he has accounted by vouchers for the whole Exchequer money.

It has been mentioned that Jameson, in 1826, had already filled all the halls and galleries of both Museums, and at that time he had exerted himself much to get the Museum extended to the west. He reported and memorialized the Crown, the Town, and the Senatus on the subject, but without success. Still we find he never dropped the matter; and we hope to be able hereafter to shew that before his death he actually carried his long-wished-for scheme into effect—and that was to extend the Museum to the west, and to convert the whole into a National Museum.

It must not, for a moment, be supposed that he was adverse to the Museum being thrown open to the public free of charge; on the contrary, he was ever most willing and anxious, but as he had no means for its support, it was not in his power to gratify the public. But he carried his feelings out as far as he possibly could, by admitting now and then large and numerous bodies of operatives—and on one occasion, at the request of the Lord Provost, by throwing open the Museum one whole day to the industrious artizans of the city only, which gave him much delight.

The following extracts from his evidence before the Royal Commission, the one on the History of the Museum, the other on the funds, confirm what has just been said:—

History of the Museum from the year 1804 *to* 1826.

"On my appointment to the chair of Natural History in this University, in the year 1804, the Museum was so inconsiderable, that the whole of the articles were contained in a few cases. The specimens were of birds, serpents, minerals, and dresses and weapons of savage nations. The birds were in so decayed a state, that I was forced very soon to throw them out, and thus the original collection was reduced to a few glasses of serpents, a small collection of minerals, and the arms and dresses already mentioned. The collection of natural history of my predecessor, Dr Walker, which contained many interesting objects of natural history, was removed from the college by Dr Walker's trustees. I placed my own collection of natural history in the Museum, and continued collecting in always, as far as my influence, and the funds in my possession, would admit of, from 1804 to 1819. I even found the accommodation too small, and therefore applied to the Town-Council for further accommodation. This was granted to me, and a very spacious and handsome Museum was fitted up for the reception of the articles of natural history. During this period the Museum was also materially enriched by the addition of a collection of minerals and books (the latter of which have since been placed in the College Library), left to the University by the late Dr Thomson of Palermo, and by the collection of minerals of the late celebrated Dr Hutton of Edinburgh. In the year 1807, on my suggestion, an application was made to the King for His Majesty's permission to have circulated from the different public offices, printed instructions for collecting objects of natural history for the Museum. This request was graciously granted, and those instructions were speedily widely circulated, and have proved most beneficial to the Museum. The collection towards the close of this period had increased so much that I was forced, as before the fitting up of the second Museum by the Town-Council, to pack up the articles of natural history, and stow them away in cellars and garrets, every case being literally crammed with specimens. It was now necessary to look out for another Museum, and fortunately the buildings in the New College, intended for the Natural History department, were in progress. I stated to the Commissioners for the College Buildings my wants, and the certainty of the destruction of many of the specimens, if kept much longer packed up in the manner already mentioned. The Commissioners being convinced of the urgency of my demands, gave orders for the speedy finishing of the splendid halls and galleries of the *New Museum*. During the fitting up of this Museum, an interesting and valuable collection of objects of Natural History, the property of Mons. Dufresne, assistant in the Garden of Plants in Paris, was offered for sale. This collection was carefully examined by agents, sent by the College to Paris, and being found fully worth the sum demanded for it, was purchased by the Professors for the Museum. About the same time a good many valuable articles of Natural History were purchased by the order of the Professors at the sale of the cabinet of the late Mr Bullock. These collections, and those contained in the first and second Museums, were brought together and arranged in the Museum in the New College, in the year 1820. Since that time the Museum has increased more than at any former period, so that the collection is nearly double what it was in 1820. About a year ago I again stated to the Commissioners for College Buildings, that further accommodation for objects of Natural History was wanted, the cases in the New Museum being completely filled. The Commissioners, with their usual liberality and activity, after considering my proposal, ordered a suite of rooms, five in number, to be immediately fitted up. This series of rooms, at the time this report is writing, is nearly filled with beautiful and interesting objects of Natural History. The Museum is rapidly increasing, and will, ere many years pass, equal in extent and splendour some of the most distinguished museums in other parts of the world.

"In order, however, to enable me to realize those hopes, another series of rooms must be provided. The Commissioners for College Buildings, to whom I have again applied, are now considering of the propriety of erecting another Museum of Natural History, on the ground to the westward of the present Museum."

History of the Funds of the Museum from the Year 1804 *to* 1826.

"At the period of my appointment to the chair of Natural History, that is, in 1804, there was no regular allowance for the maintenance and increase of the Museum, and the only resources I had to look to were occasional assistance from the Town-Council and my own private funds. From the year 1804 to the year 1812, the expenses of the Museum, in collecting, receiving, and preserving objects of Natural History, servants, and other expenses, were partly paid by the Town-Council and partly by the Professor of Natural History. The increasing expenditure of the Museum, and the want of regular funds, induced me in the year 1812, to lay a statement on this subject before the Honourable the Barons of His Majesty's Exchequer in Scotland.

"The result of this application was a gracious order from His Majesty, that £100 should be paid annually to the Professor of Natural History for the use of the Museum. From the year 1812 to the year 1820, when the Museum was for the first time open to the public, the Museum funds were,—the annual grant of £100, occasional allowances from the Town-Council, and my own funds. In the year 1820, the debt on the Museum having accumulated considerably, and being further increased by the annual payment of the interest of £3000, borrowed by the Professors from the Banks, for the payment of the Dufresne and Bullock collections, it was found necessary to make some arrangements to meet these difficulties. At a meeting held in the Museum, attended by representatives from the Court of Exchequer, the Court of Session, the University, and the Town-Council, I was ordered to open the Museum to the public, and to see that each visitor paid two shillings and sixpence of admission money. From the year 1820 to 1826, the Museum has been supported by the money collected from visitors; the royal annual grant, and advances by the Professor of Natural History; the Town-Council, from the period of opening the Museum to the public, having considered it unnecessary to grant any further pecuniary aid to the Museum establishment.

"Although this fund has been productive, still it is not sufficient, even in its present state, and when aided by the royal annual grant, to keep the establishment free of debt. This being the case, it is evident that some certain and permanent income must be provided, in order to secure the Museum already formed, and to afford the means of preserving and of purchasing such specimens as are absolutely required, in order to keep the Museum up with the progress of Natural Science."

To shew further the difficulties Jameson had to contend with from want of funds, he reported to the Royal Commission that "the Museum—the most interesting in Great Britain—the result of upwards of twenty years' labour on my part—is now in so low a condition as to pecuniary means that I (a keeper without a salary) was forced some time ago to part with my assistant, and to take on myself the whole duties of this important and extensive department of the Museum. The present establishment (1830) for the Museum is the Professor of Natural History, assisted by a man to keep the door and stove, and a woman to wash and dust the room."

Here we find Jameson supporting the now National Museum by his own energy and his own purse. Has he ever for all this received a debt of gratitude from his country? No! But Europe expects it.

The introduction of the new Heating Apparatus.

Jameson lodged many complaints with the Authorities for a long series of years, in regard to the inefficient manner in which the balls and galleries of the Museum were heated; and he pointed out the certain destruction of the collections, either if some alteration on the old system was not adopted, or a new system altogether introduced. This led to a committee being appointed to inquire into the matter. The committee ordered the furnace to be pulled down, and reconstructed on a plan more likely to throw a larger volume of heat into the halls, and less dust; but the experiment proved a complete failure. A new system of heating altogether was recommended, which had been in use several years, viz., that of Perkins. Jameson, after a good deal of anxiety and trouble, obtained the sanction of the Patrons of the University and the Senatus Academicus to introduce this admirable and truly useful system of heating into the Museum, and to remove the old system entirely, which was agreed to.

The halls and galleries are now well heated and perfectly free from dust. Still, I may add, that it would require two more coils to supply the whole apartments of the west Museum with a proper temperature, viz., a coil in the British gallery, and a coil in the class-room, which might be introduced at a small expense. I hope the patrons will not lose sight of this, as the perfect safety and durability of the collection will depend on it.

Museum extension is a subject that Jameson has urgently moved in since 1826, but his anxious call was never listened to; nevertheless he went on extending and improving the Museum in all its departments in his usual way.

In 1852 he drew out a statement of the many thousand valuable specimens that could not be exhibited for want of proper accommodation, and laid this before the Town-Council, who at once entered into his feelings, and saw the actual necessity of urging Government for a grant to extend the Museum to the west. The Lord Provost, Magistrates, and Council, submitted to the Right Honourable the Lords Commissioners of Her Majesty's Treasury, a memorial for Museum extension, and for converting the present Museum into a National Museum for Scotland. Jameson, as keeper of the Museum, forwarded a strong memorial of the same nature. Government appears to have taken those memorials into serious consideration, as it is now understood that the feelings of the Government are awakened on this important subject, and that ere long we may expect to see the foundation-stone laid for the new Museum.

Jameson has left all the collections in the Museum, both of the animate and inanimate kingdoms of nature, in the best order. It is true that many complaints have been made in regard to the apparent confusion the collections appeared to be in, but this was altogether owing to the want of accommodation. For example, the Mammals could not be classified and systematically arranged in the same hall, owing to the want of glass-cases to contain the smaller quadrupeds; the collection is therefore distributed throughout the different apartments of the Museum, entirely for convenience. The same applies to the birds, fishes, and reptiles. The mineral collection, as every mineralogist knows, is arranged in the highest systematic order. Neither the public nor naturalists have any reason to complain of the apparent want of systematic arrangement of the collections, as Jameson had to restrict the arrangements to suit the accommodation of specimens; but let it be remarked that the natural grouping is always carefully preserved, with a few exceptions, confined not only to specimens exhibited, but also to those unexhibited; therefore, the whole collection may be considered in order either for arranging and cataloguing, or for transferring to the new Museum when completed.

Numerical Statement of the Museum Collection.

The following numerical list will shew the vast extent of the collections that have been deposited in the Museum during the reign of Jameson, by far the greater part of which cannot be exhibited for want of proper accommodation.

WEST AND EAST MUSEUMS.

Mammals stuffed and in skins, . .	619	
Birds stuffed and in skins, . .	8558	
Fishes, ...	500	
Reptiles, ...	400	
Invertebrate animals, . . .	500	
	———	10,577

We give more in detail the mineralogical, geological, osteological, testaceological collections, and the collections of fossil organic remains:— ———

Carry forward, . 10,577

Brought forward,		10,577

MINERALS.

Collection of specimens laid out and arranged for study,	3973	
Collection of specimens in drawers, upwards of	3000	
Total,		6,973

ROCKS.

Europe.

Specimens from Jan Mayen Island and Spitzbergen,	100	
Iceland,	400	
Norway,	700	
Finland,	75	
Uralian Mountains,	165	
Scotland, including the counties of Caithness, Sutherland, Cromarty, Ross, Inverness, Perth, Banff, Aberdeen, Kincardine, Argyle, Ayr, Lanark, Roxburgh, Dumfries, Wigton, Galloway, Clackmannan, Mid-Lothian, East-Lothian, West-Lothian, and also the Orkney and Shetland Islands, &c.; the Hebrides, as Skye, Canna, Rum, Eigg, Coll, Tiree, Iona, Mull, St Kilda, Rasay, Pabba, Arran, Bute, and Cumbray,	5000	
England and Wales,	2000	
Jersey,	150	
France,	1500	
Vosges,	302	
Spain,	300	
Gibraltar,	200	
Germany, including Hanover, Hessia, Rhineland, Saxony, Wurtemberg, Thuringia, Bohemia, Moravia, Bavaria, Austria, Hungary,	4000	
Switzerland,	200	
Italy, Greece, and the Greek Islands,	300	

Africa.

Egypt,	150	
Sierra Leone,	150	
Cape of Good Hope and Caffraria,	600	
Azores, Madeira, Canary Islands, St Helena, Mauritius,	200	
		16,492
Carry forward,		34,042

Brought forward, .		34,042
Asia.		
Persia, ...	200	
Armenia, ...	200	
Continent of India, . . .	1000	
Indian Islands, as Java, Singapore, .	300	
America.		
Greenland, ...	200	
Canada, ...	150	
Hudson's Bay, ...	100	
Nova Scotia, ...	150	
United States, ...	160	
Newfoundland, ...	100	
Mexico, ...	300	
Labrador, ...	50	
Columbia, ...	50	
Brazil, ...	200	
Australia and Polynesia.		
New Zealand, Otaheite, Sandwich Islands, and other islands in the South Seas, .	350	
Australia, . . .	1200	
		4710
		38,752

In addition to those enumerated above, there are in the Museum collections made during the voyages of Captain Ross, Captain Parry, Lord Byron, Sir John Richardson, and Captain Fitzroy, and various others. The specimens of English and Irish rocks and fossils promised to Professor Jameson by Sir Henry de la Beche are lying in the Economic Geological Establishment of London.

OSTEOLOGICAL AND TESTACEOLOGICAL COLLECTIONS.

Skeletons of mammals, birds, fishes, and reptiles,	118	
Human skulls in comparison, . .	199	
Crania of quadrupeds, birds, fishes, and reptiles,	531	
		848
Fresh or recent shells, . . .		8,000
Carry forward, . .		47,600

Brought forward,		47,600
FOSSIL ORGANIC REMAINS.		
Tertiary Fossils.		
Tertiary fossils from Scotland, England, France, Sweden, Italy, Bessarabia, Persia, Egypt, India,—all named and arranged,	2939	
Secondary Fossils.		
Secondary fossils from Scotland, England, Germany, France, Belgium, Bohemia,	5034	
Silurian Fossils.		
Silurian fossils from Scotland, England, Germany, Bohemia,	680	
Fossils not yet arranged,	500	
		9,153
Insects,		16,000
Birds' Eggs,		1,000
Drawings, maps and models, upwards of		700
		74,453

A high mark of honour was conferred upon Jameson by the members of the Wernerian Society, some of his colleagues, and many of our most distinguished citizens, in getting a bust of him executed in marble by our far-famed and celebrated artist Mr Steel. This noble piece of masterly art of Mr Steel is the most truthful likeness of the veteran Jameson that now remains. It is true that we have lost his spiritual vitality, but still we have the true image with the spiritual features, or the inanimate matter spiritualized by the hand of man in Steel's bust. The bust stands on a white marble pedestal in the centre of the Upper Hall of the University Museum, a position where his fellow citizens will, I am sure, be proud to see it.

In addition to what we have said of Jameson we now add four letters, one received from his old pupil, Earl of Cathcart, one from L. Elie de Beaumont, who writes in the name of the Institute of Paris, a third letter from A. Baumgartner, who writes in the name of the Imperial Academy of Science of Vienna; and a fourth from the University of Bonn.

We are in possession of many highly important letters from other European academies, but have not space for more at present.

The Earl of Cathcart, in his elegant epistle remarks, " There is no person more willing than I am to render honour where honour is so justly due, as it is to the highly venerated Jameson." His Lordship continues, "it will be difficult to find a successor to one who has done more than any man now living, by his laborious exertions, to enlighten his fellow-countrymen, and the world at large, in a department of science, which at the commencement of his labours, was in its infancy; and involved in a labyrinth of vague theories, that required all the powers of a mind like that of Professor Jameson, ardently devoted to the cause of science, to find a clue to the path, which by a careful and impartial collation of the new facts which were daily developing themselves, would ultimately lead to the truth. The exemplary patience with which he proceeded, step by step, in the progress of the mission he had undertaken, was only equalled by the candour with which he was always ready to acknowledge an error, even to the sacrifice of the cherished opinions in which he had been early educated, under the celebrated Werner, when he found them to be no longer tenable. An instructor, with a mind so trained and disciplined in the search of truth, could not fail to secure the esteem and confidence of his pupils, and to impart to them the same love and ardour in the pursuit of science, that he himself possessed; amongst whom, during the long course of upwards of fifty years, may be reckoned many of the most celebrated naturalists, not only of his own country, but in all parts of the world in which natural science is cultivated. For myself, who have had the privilege of attending Professor Jameson's class, and of accompanying the Professor in some of his geological excursions, I cannot say which gave me most pleasure to witness, the devoted attention of his pupils to the lucid explanation of the phenomena which had come under our observation; or the affectionate regard we all felt for the amiable qualities of our venerable instructor. Although Professor Jameson has preserved his mental faculties in their full vigour, to a much later period than is allotted to most men, their constant exertion in such severe labours must necessarily impair, be prejudicial to health, and tend to produce bodily infirmity. His time is now come when he should retire from public life, and pass his latter days in calmness and repose.

"And I most earnestly hope that the proposed appeal to Lord Aberdeen may be successful in obtaining for him some honourable distinction, to mark the estimation in which the eminent services he has rendered to science is appreciated by a grateful country, during his lifetime. Hereafter no name will be handed down to posterity with more lasting honours than that of Professor Jameson. Believe me, my dear sir, always very truly yours, CATHCART."

"*Paris, April* 1854.

"I deeply regret," says M. L. Elie de Beaumont, "for the cause of science, that Jameson is not able to carry on his brilliant prelections, being unable to struggle against the weight of years; but I am sure that all friends of science, deeply grateful for his noble and persevering exertions, would much deplore if he were to hazard his health by resisting too long to the inevitable blows of time; and I am at the same time convinced that they would regret that the period of repose, now so necessary to him, should commence without being signalized by a great and honourable tribute of gratitude, which is due to him for the services he has rendered to his country, his university, and, I may add, to the whole of Europe, by having powerfully contributed, by the splendour of his instructions, and by his learned labours, to exalt the study of natural history.

"Such indeed is the sentiment of all the members of the Academy of Sciences of Paris, who have cultivated those branches which Professor Jameson, by his labours, has most advanced; and I may add, that the Academy, along with myself, should feel most happy if a public mark of respect was bestowed on the illustrous author of so many famous works, well known to the whole of Europe—the learned editor of the Philosophical Journal—a journal much prized by every lover of science, and by all our academies—the eminent Professor, who has formed so many students, and who in their turn became celebrated savans—and for the enlightened and benevolent guide from whom I myself had formerly the honour of receiving instructions in that very locality, when under his auspices I visited the spots in the neighbourhood of Edinburgh, which, by his beautiful observations have become classic ground to the geologist. I remain, my dear sir, yours sincerely.

"M. L. Elie de Beaumont,
and
"M. Flourens, Perpetual Presidents of the Academy.
Ch. Coumbes, President.

"I join with great pleasure," says M. Flourens, "the sentiments of high esteem expressed by M. Elie de Beaumont, in his wishes that a just and honourable tribute of respect should be paid to Jameson by his country."

"Milne-Edwards.
A. Valenciennes.
Boussingault.
Payen.
Gasparin.
Francois Delessert.
Baron Charles Dupin.
C. Dumeril.
Balard.
M. Dumas.
M. de Senarmont.
Constant Prevost.
Adl. Brongniart.
Jules Decaisn.
M. Faye.
Eug. Peligot.
Babinet."

The Imperial Academy of Sciences of Vienna, in a letter received, say,—"We have the honour to lay before you the expression of their high feelings and high personal regard in the important benefits Professor Jameson has bestowed on science. The Academy has a lively sense of the relations that at one time existed between Jameson and the celebrated Frederick Mohs of Freyberg, while under the tuition of Werner, as well as of that later scientific intercourse, which induced one of our most active members, M. Haidinger, to publish in Edinburgh the English edition of Mohs' well-known System of Mineralogy. These observations point out the intimate relations which existed in earlier times between Jameson's labours in the field of the modern period of mineralogy and the history of that science in our own country.

"Well may a man in the evening of his life experience some satisfaction, if, like Jameson, he is able to look to a long uninterrupted period—by his intellectual activity a period amply filled up by his own labours and works which promoted and advanced science—by the establishment of a learned society (Wernerian) that the country derived so much good from—and by the founding of a journal of independent character, which has been a great boon to the country for more than 35 years.

"We are happy on our part to express, in the name of the Academy, the high position which Jameson held for his brilliant services to his sovereign and country.

"A. Baumgartner.
A. Schrötter,
General Secretary of the Imperial Academy."

"*Vienna, May 3d*, 1854."

From these letters, and many others, we find that Jameson's reputation early in life depended in a great measure on his mineralogical and geological knowledge.

At the commencement of his career he devoted much time and close investigation to the structure of rocks, and would have worked out many useful results had he continued, because it is undoubtedly true that a close investigation of structure will lead us to the laws, from the operation of which the harmony pervading nature results. The old school of geology was too much inclined to ascribe the varieties of structure to increased or diminished pressure; but there appears to be in nature causes independent of variations in pressure—the cause of these changes still puzzle and perplex the best of our geologists. Studer and Keilhau tell us that chemistry fails to account for them. We hope soon to see truly valuable results, derived from the microscopical examination of rocks. If the beautiful experiments of Ebelmen had been known when the battle of the Huttonians and Wernerians was at its height, they would have been highly prized, as they would have settled the keenly contested question as to how apparent infusible substances could be fused, and how fusible and infusible substances occurred together. We now know from his experiments that fusible substances contain dissolvents which act on the infusible substances and dissolve them.

Jameson was the first who observed a concentric laminar structure in granite; and he was the first who started the notion of the contemporaneous formation of rocks in this country.

We have now given a very brief outline of Jameson's career, and we trust his last and dying feelings in regard to his Museum, so well known to the Patrons of the University and his Colleagues, will be ultimately realized, and fully carried out. We have further shewn that Jameson has led a long, a highly useful, and, I may add, a truly happy life,—a life that has reaped enjoyments on this earth of an order of immortal beings,—a being, although clothed with mortality, and subject to the ordinary passions, infirmities, and possessing a mind that craved unceasingly for the expansion and improvement of the intellect that God had given him to elevate and enoble his mortal existence; and a mind that, even while so imprisoned, could grasp the whole of nature, and turn his knowledge to the progress, improvement, and benefit of his fellow-creatures. Such powers and faculties in a perishable fellow-creature, are enough to excite man's highest admiration, and to lead him to feel that such gifts and faculties are not doomed to perish, but that the mind of man is immaterial and immortal. His soul is now safe in its immortal habitation, where there is neither death nor sorrow. Death knocked at the door, and it opened, and his finer being was transferred from a lower to a higher state of existence, to immortal happiness.

The feelings of the University of Bonn as to the value and worth of the late Professor Jameson appears in the following address, received from the Professors of that University:—

"At a time when the oldest of the undersigned were still boys, and the youngest not even born, Professor Jameson was a student in the celebrated Mining Academy of Freybreg. He, along with many distinguished foreigners, was attracted thither to study under the famous Werner. Jameson was one of Werner's most zealous pupils; he supported his doctrines throughout life, but at the same time shut neither his eye nor his ear to the progress of science in those phases through which it passed in the course of time. Jameson manifested his devotion and gratitude to that never-to-be-forgotten teacher, Werner, by the establishment of the Wernerian Natural History Society, to which Europe is deeply indebted, by the many treasures he collected there in the field of science. Jameson was highly favoured for half a century as a great teacher, as an author, and as a distinguished philosopher, with perfect success. Great as is the number of those who, by word and doctrine, were instructed by him, it is still far surpassed by the number of those who derived manifold instructions from his numerous and valuable writings.

"The Edinburgh New Philosophical Journal is a marked proof of Jameson's talents and unwearied industry,—a journal so rich in its contents, and in having kept pace with the progressive discoveries and improvements in the arts and sciences,—and a journal that will at all times maintain a most prominent position in the libraries of the learned. Such merits, joined to great urbanity, benevolent, and noble character, could not fail to be appreciated; and the great esteem and respect in which his name is upheld by all the academies and learned societies in Europe, America, East and West Indies, to which he belongs, is a decided proof of this.

"May his God soon improve his suffering state of health, and may He give him many years of calmness and repose.

"Dr BUKER, Dean and Professor of Mathematics and Physic.
Dr GUSTAVE BISCHOF, Privy Mining Councillor, and Professor of Chemistry.
Dr NOEGGERATH, Privy Mining Councillor, and Professor of Mineralogy.
Dr FR. ARGELANDER, Professor of Astronomy, and Director of the Observatory.

L. J.

"BONN, 13*th May* 1854."

On the China-stone and China-clay of Cornwall. By Mr H. M. STOKER, of St Austel, Cornwall.

(Continued from vol. lvi., p. 102.)

Kaolin is found intermixed with quartz and scales of mica, in most valleys contiguous to the decomposing hills of the primary strata of our county, and is not, so far as is at present known with regard to China-stone, confined to any particular district, being now obtained or obtainable, though of different qualities, on the south-western sides of either of the granite districts; yet, of course, poorest near those beds of China-stone which I before described as free from most deteriorating substances, as in the parish of St Stephens.

It exists in these beds or stopes, as they are designated, as an amorphous, whitish-blue, opaque powder, which, from the softening influence and rainy character of the south-westerly winds, are most frequent in valleys situated on the same aspect; often lying on the contiguous borders of the granite and killas, clay-slate, greywacke or transition strata, by which this is surrounded; where, being exposed to the action of lodes and co-existing springs, on the occurrence of the slightest convulsion, it has slid to the adjacent valleys, where its presence is indicated by the generally smooth and flattened appearance of the surface,—by the vegetation on it, which is often luxuriant, especially if the clay contain an excess of potash,—and by the number of springs to which it gives rise in the immediate vicinity, their height above the level of the sea being necessarily limited by that of the valleys in which the clay is deposited.

The character of the clay very much assimilates to that of the granites from which it has been formed by the disintegrating process to which I referred while speaking of the formation of China-stone, not only as to the quantity obtainable from a given amount of clay-stope, but also as to the purity of the article and its whiteness, the whitest clay being formed from that granite which has the whitest felspar, and is most free from iron, the presence of this giving the manufactured wares an appearance termed "foxey;" while, lastly, the amount of mica scales, which give to them their tenacity or strength of body, considerably influence the character and value of the clay; so that, as a general rule, we can form a very good diagnosis of the character of the clay by an examination of the granite from which it has been formed; and in doing this, I would advise the use of a good microscope, by which only the clay producer can hope to obtain an accurate knowledge of the value and purity of our clays.

The kaolin of both Devon and Derbyshire is of good working quality, but can by no means compare with that of our county either for whiteness or strength; it contains 60 of alumina, 20 of silica, and 20 of potash (Wedgwood); and to this peculiarity of constitution (excess of silica) is due its property of being infusible and unchanged at the highest temperature. It is extremely tenacious of moisture, and hence one great difficulty in its preparation;—to be hereafter discussed.

The clay beds, or stopes, are formed by small irregular crystals of quartz, the edges of which are by no means so well marked as in the granite, nor is their opacity so great: the mica is apparently unchanged, consisting of silicic acid, potash, and alumina, in the form of double silicate; while the felspar of the granite or China-stone, by the loss of its potash, has become converted into the amorphous powder I have just described; a singular instance of the effect of slight natural chemical changes giving rise to the formation of two such dissimilar bodies, when fused, as biscuit China, white, glassy, sonorous, and translucent; when, if the disintegrating process have but just overstepped this limit, we find, on fusion, a brick-like mass, white, opaque, adhering to the tongue, tenacious of moisture, and earthy on fracture. There are, however, as I before stated, many and varied intermediate productions, from the pasty pipe-clay or tile, to porcelain or glass, which is but another form of a fusible silicate. The clay stopes are oftentimes rendered useless by the presence of some iron lode, which causes them to become loosened in texture, and reddened; the stope is then termed "brawny," and this has to be thrown aside as useless.

Having thus briefly given a general outline of the nature, composition, and history of these clays, I shall proceed to the notice of the mode of preparation of them in this county, which, though simple in theory, requires much care and attention in its execution, and consists essentially in the separation of the quartz from the mica and kaolin, and the subsequent collection of the latter. The execution of this process in any of the extensive works in St Stephen's parish, one of which would cover from 10 to 13 acres of ground, and from which 2000 to 3000 tons are annually raised, and fitted for the market, forms a curious and interesting spectacle of whitewashed, happy industry, for the contemplation of the traveller during the months of summer.

Distant from five to eight miles from St Austell, situated in the centre of barren, rugged, heathery wilds, inclosed by stone walls, and bounded on every side by cold, bleak, and rugged hills, these works have a very picturesque appearace. In one part of them may be seen from 30 to 40 men, boys, and women, who, with their white bonnets, white aprons and sleeves, carry the still whiter clay, in large junks, to the surrounding hills or drying grounds, to be exposed to the warm rays of the sun, the dry winds, and the bleaching power of the air; in another may be seen other parties scraping the clay, prior to its being packed in casks, to be sent to various parts of the old and new world. Circular or oval pits and square pans are lying in all directions; their continuity here and there disturbed by one or two water-wheels in incessant motion, or piles of dried clay covered with reeders, or lying in sheds; while at one extremity of the work may be seen a number of men and boys employed in excavating the clay stope, removing the overburden, or shearing the stope to wash away its clay; the sand at the same time being removed to the drying ground by means of a tram-road, the waggons passing along which are worked by the aid of water-power; while over head launders attached to pumps for various purposes seem to form a skeleton roof to the whole.

The beds of clay stope are exposed by the removal of the overburden, which varies in thickness; in some places lying but a few feet from the surface, while in others the only bed fit to be washed is placed at a depth of from 10 to 20 fathoms from the surface. The removal of the superimposed earth is effected by a number of men with their pickaxes and shovels, which, by their barrows, they transport to the adjacent rugged country, so as to render it smooth and level, in order to form drying fields for the summer. While this is in progress, the clay stope, over the top of which flows a small stream of water, is being excavated by another set of men, which, as the water passes through, has the clay suspended in it by the treading action to which the stope is subjected, by means of the large boots, often seven pounds weight, with which the clay streamers are supplied; the sand is thus separated from the clay and mica, which are carried on by the water, and the sand is then carried by rail or carted to the top of the work, whence it is taken to be spread over the drying grounds, or is thrown into the pits and pans.

The water to be supplied to the clay stope should consist of two-thirds of spring to one-third of rain water, this mixture causing a deposit of the suspended clay much more readily than any other. Great attention is often necessary in this part of the process, as, from an excess of rain-water, it is often requisite that it should be saturated with some earthy base. Common alum is at present used for this purpose, though any other cheaper salt would answer the purpose, as it is only necessary to saturate the water fully with earthy bases, when the clay speedily becomes thrown down; a law not generally known.

As a substitute for this, I have at times had recourse to finely-ground peat, or wood charcoal, which, thrown over the surface of a pit, on which it floats, by a process of angular attraction or repulsion, causes the clay to be deposited, even from distilled water, far more readily than by the addition of any soluble earths, as may be demonstrated, with ease, by experiment in two or three tumblers; but as I am rather in advance of the water in which I left the clay and mica suspended at the bottom level of the clay work, I must return thither, till, by the aid of wooden or iron pumps, from 40 to 80 feet deep, worked by a powerful water-wheel, this milky-looking fluid is elevated to the level of the large mica launders, where the clay, being lighter than it, leaves it deposited in these inclined pits, which are generally three or four in number, placed in tiers, with a slight elevation at the upper end of each. They vary in length from 10 to 20 feet, are generally 3 feet in breadth, and 6 or 9 inches deep, though both the number, size, and degree of inclination vary with the size and rapidity of flow of the shear of water, though no less than with the amount of mica contained in the stope. In some clay works the shear is so large that most of the mica is carried on with the clay, so that it possesses, when fused, a greater degree of tenacity, though of an inferior quality as to whiteness, plasticity, &c. In the separation of the best clays, these pits require that the motion of the shear through them should be slow and equable; the shear of small size, and the launders should be tapped or cleared out once in every six or seven hours; a careful attention to which well repays any amount of labour in the production of a good article. That portion of the mica collected in the first of these launders often being mixed with scales and crystals of hornblende, or diallage, is thrown aside as useless, while that collected in the others is generally sold as a second quality clay.

The clay water, having left the mica, now flows on to a large circular or oval collecting pit, 30 or 40 feet in circumference, and from 6 to 10 feet deep, where the clay subsides, forming an under-stratum of the consistence of cream, the supernatant water flowing off from the top of the pit, until it is filled. As soon as this happens, the clay is allowed to pass out by a trap-hatch to the pans below it; or, should there be none at this level, recourse is had to the pumps, by means of which, and attached launders, the clay is passed to the drying-pans in any portion of the work. Of these there should be from ten to twelve capable of holding from 40 to 50 tons, to each large collecting pit; they have been made, till lately, on any part of the adjacent ground, frequently on that covering the clay bed, where the surface, after being levelled and covered with fine loose gravel, is hedged in by walls of granite, the joints of which, as well as those of the pits, are rendered impervious by interposed moss; they are generally from 20 to 40 feet square, and 2 deep; the pans, when two-thirds filled with clay, are thus exposed to the heat of the sun, or the dry winds of March, to the aid of which alone the proprietors of the majority of these works have hitherto had recourse.

In the model which I have sent for the inspection of the Committee of the Royal Cornwall Polytechnic Society, I have employed drainage as an additional means of aiding the drying of clay, by forming a kind of filter of the clay pan. A substratum of large pebbles, increasing in depth from behind forwards, but with the surface level, is first laid down above this coarse gravel, between which and the clay to be dried is a thin layer of fine sand; through this the water quickly runs to the corner, towards which the inclined bottom is made to fleet, which communicates with the country by means of a launder, over the inner end of which is placed a wire-gauze grating. By the employment of these, from experiments I have made, I have ascertained that the clay can be dried thrice as rapidly as by the ordinary methods; in addition to the introduction of which I should recommend to the notice of parties employed in these operations, the propriety of placing these pans as closely together as possible, so that, on the occurrence of heavy showers of long duration, or in the heavy dews of the nights of summer, the clay may be kept from this accession of moisture by some cheap covering, as these obstacles very much increase the difficulty of drying clay in any given period.

The kaolin is by this means only partially deprived of moisture, in order to effect the complete removal of which it is taken from the pans, where it has been allowed to remain for from three to four months, to the drying grounds, on the adjoining hills, in summer, in cubic blocks about 1 foot square. In order to effect its removal from the pans, a number of parallel incisions are made the whole length of the pan, in one direction, by means of a perpendicular knife attached at right angles to a long handle. These long blocks are then divided transversely by men, who with spades throw them on a board, on which they are carried by women and boys to the sandy drying-yard, where they soon become perfectly dry and white; but as this can only be done in summer, and not even then if a wet season, it has become necessary that recourse should be had to other means: those hitherto employed have all required the use of a fuel obtainable only from Newport, or some distant coal tract, and hence requiring considerable outlay, so much so, in fact, that but few persons are able or willing to make use of it. The heat, in these cases, is applied by means of a large kiln, or by passing the clay over a heated drum, neither of which methods could be made available in the return of several thousand tons of clay annually.

But it occurred to me that the deleterious floods of the winter, or the wind on the adjoining hill, might be rendered available as a motor power, provided it could be employed in the construction of a kaolin drying-machine. The success of my attempts will be best learned by a few turns of the handle of the accompanying model made and invented by the author. By a machine twelve times the size of the model, two tons of clay can be dried completely every five minutes. It consists of a number of perforated fans, having on them shelves similarly perforated, or made of wire-gauze, which are kept rotating two hundred times a minute, or faster if necessary, by the four attached multiplying wheels. These wheel-fans have six perpendicular screw-like arms, on each of which are a number of transverse shelves for the carriage of the clay, where, from the rapid motion of the wheel, and the opposed currents of air it causes to be thrown against the clay, it rapidly becomes dry.

The fact of doing away altogether with fuel, and the substitution of a power which can be obtained with the greatest ease, on the occurrence of a very rainy season, render it at once a cheap and advantageous substitute, either for the labour at present employed, or for the still more expensive fuel.

The junks of clay, after being again collected, are now piled away in sheds, under a number of thatched gates or reeders; or are placed in some sheltered spot, so that they may, nevertheless, have a constant current of cold dry air surrounding them, and be at the same time kept from rain.

When required for exportation, these square blocks are scraped by a number of the clay women, who, armed with their "Dutch Hoe"-like instruments, as they surround their scraping tables, present a rather formidable appearance; after this the clay is piled in waggons, to be sent from one of the nearest ports, or is packed in a number of small casks, each capable of holding about half a ton, in which it is sent off.

The prices of these clays vary much with the quality of the article, though those of a superior stamp seldom alter, as they have held their price for the last ten or fifteen years, and always command an excellent sale in the market at from 36s. to 46s. per ton; while those of an inferior quality may be procured at any price below this down to 17s. per ton, varying with their purity, hardness after calcination, degree of whiteness both in and out of water, and, lastly, the degree of shrinking they undergo on calcination or fusion.

Having already entered, as fully as the limits of the present essay will permit me, on the subject of the uses of kaolin, further information on that head must be dispensed with; but, before concluding, I must introduce to your notice a few facts, bearing directly on the influence the preparation and production of this article exercises on this, the central portion of the county. The first and most important of which is the number of people employed in its preparation, and the amount of capital expended annually in labour; next, I shall shew the amount of the cost of land dues; thirdly, that of land carriage, which will necessarily afford additional aid to the labourers in the vicinity, as the whole of this work is executed by a number of small farmers, each of whom is generally provided with his waggon and team of from three to four horses. The cost of cooperage and quay-dues is next on the list, forming a total of £240,500 spent in the preparation and production of this article in this county alone. But it should also be recollected that no less than 80,000 labourers are employed in the neighbourhood of the Staffordshire potteries, and 20,000 more in those of Derby, Worcester, Wales, and Bristol, in its subsequent manufacture; for which, prior to its arrival in or at either of these districts, a sum of 12s. per ton, for carriage by sea and canal, is entailed, forming a total of about £300,000 spent on China-clay and stone before they arrive in the potteries, where an immense amount of capital is again spent in their manufacture.

	Yearly Expenditure.
Labour, 7200 men, women, and children, at 1s. 6d. per diem,	£197,100
Carriage of clay and stone to one of the nearest ports, at average price,	22,000
Dues to landowner,	14,000
Dues to proprietors of harbours,	2,500
Cooperage on best clays,	5,000
	£240,600
Land and canal carriage, at 12s. per ton,	58,800
	£299,400

Having thus, as briefly as possible, stated the chief facts with which I am acquainted relative to the history, preparation, and commercial importance of these articles, and pointed out the advantages to be derived, and the field of improvement which is offered for the contemplation, study, and enterprise of Englishmen, by substituting machinery for the great amount of manual labour and cost, at present necessarily entailed by the existing want of information on this subject, I must conclude by again calling attention to the distance of these beds from the potteries and their surrounding beds of fuel, and suggesting that substitution of the transfer of materials, at a subsequent period, may considerably alter the present state of the central portion of the county, and with it the price of the various articles of pottery so necessary to our comfort and convenience.—*From the Proceedings of the Royal Polytechnic Society of Cornwall.*

On the Paragenetic Relations of Minerals.

Continued from Vol. lvi., No. cxii.

The so-called gelbbleieeze or molybdates of lead are the most remarkable products of the decomposition of galena, for with regard to their formation the question arises, whence did their molybdic acid originate? It is scarcely admissible to assume that molybdic acid or molybdate of lead were introduced into the lodes ready formed, since under all circumstances the molybdates are implanted upon the galena, or occur as pseudomorphs after it, like other minerals of the kind, with regard to the source of whose acids there is no doubt. It would seem that the molybdenum previously existed in some decomposed mineral which has not as yet been met with. Chemical examination of the galena itself did not show the presence of any molybdenum in it.

The zinc-blende of this formation is generally of the brown, rarely of the red or yellow colour, and never black.

Copper pyrites occurs in small quantity as one of the oldest members of this formation. A great variety of decomposition products of it and of galena conjointly occur, particularly in the upper parts of the lodes.

XV. *Barytic Copper Formation.*—It has already been pointed out that copper pyrites occurs frequently in formations whose principal bedding is barytite. Variegated and ordinary copper pyrites, together with copper-glance, occur in considerable masses in barytite lodes, without any other minerals so as to constitute what may justly be regarded as a special formation.

XVI. *Silver Formation.*—As in the previously mentioned quartz formation, the argentiferous and auriferous pyrites are almost invariably associated with mispickel and quartz, they may be regarded as constituting a separate formation, more especially as their age is undoubtedly very great. However, argentiferous minerals are elsewhere more abundant, and so decidedly associated with and accompanied by the very recent barytite, that they may likewise be regarded as a separate formation. It resembles the pyritic formation in being frequently transferred into the adjoining rock, although not in such considerable masses, and the rock is less disintegrated. Silver glance has been found between the planes of cleavage of undecomposed gneiss. The minerals containing gold or silver which belong to this formation are generally of very recent formation, and are consequently implanted upon most of the previous groups, except the titanium and manganese group, and probably the spathic iron, tin, cobalt, and nickel-silver group, and that in zechstein, &c. The formation is most considerable when bedded in barytite. The enormous quantity of silver ore yielded in 1477 by the mine Ritter St George, at Schneeberg, was situated at the intersection of several lodes of heavy spar. The rich ores of Peru, Chili, and Mexico, were mostly found in heavy spar lodes, with and without quartz.

XVII. *Barytic Mercury Formation.*—Cinnabar stands in the same relation to heavy spar as the cobalt and nickel minerals. This is also true even of the mercurial fahlerz, it being older than the heavy spar. This formation is most characteristic in the rich auriferous sandstone of Rhenish Bavaria.

XVIII. *Zeolite Formation.*—Several zeolites occur in todes, even in those bearing metallic ores, and their formation has taken place during a period more recent than that of the other lode substances. Their appearance here is so peculiar as perfectly to justify the assumption of a zeolite formation.

It is remarkable that they occur not only in the more recent eruptive rocks, in whose vesicular cavities they are especially at home, but also in much older rocks. But in all cases, it is probable they can only be products of extraction and lateral secretion. The absence of magnesium and iron is characteristic of the zeolites, and neither the vesicular cavities nor the lodes in which they occur contain at the utmost more than a trace of minerals containing these radicals.

XIX. *Phosphate Formation.*—The minerals mentioned when treating of the descension theory belong to this formation, but we cannot assume that they were formed at any particular period. There is no doubt that many are formed at the present time. (Vivianite, pyreneite, wavellite.) It likewise appears fit here to enumerate the several species of phosphates, rather than to seek for other groups, especially as it is probable that none of the phosphoric acid is derived from the adjoining rock, or from the apatite in other lodes.

The uranites occur in lodes in granite and such as separate granite from schistose rocks. Calcareous uranite is accompanied only by quartz at two places, near Schneeberg, at Steinig (Voigtland), and likewise in iron and manganese lodes in some mines at Johanngrogenstadt, generally upon red jasper. Chalcolite occurs in the same lodes on quartz or red jasper. The circumstances of their occurrence render it probable that the granite on both sides of such lodes contains a uraniferous mineral, disseminated so finely that it has not yet been recognised. Such uraniferous minerals have been found imbedded in granite, as at Redruth in Cornwall.

The beraunite, kraunite, kakoxene, &c., in lodes of slight depth in Bohemia, have perhaps likewise derived their phosphoric acid from the surface.

Pyromorphite and the phosphates of copper belong here as the most recent products of the decomposition of cupreous minerals, and the arseniates of copper generally contain some phosphoric acid. These are thus proved to have been derived from above.

Childrenite, belonging to the same genus as skorodite, is likewise recent.

Vivianite occurs upon quartz, spathic iron, and iron pyrites, in Wheal Betsy, Tavistock, Wheal Kind in Cornwall, and in Hungary. In Bavaria, thraulite occurs between them. Wavellite occurs alone or with peganite and anhyposiderite. To these may perhaps be added pleurokens, triphylin, hetepozite, triplite, zweiselite, and lazulite. It is not said that these all belong to the same formation, so much as that they are the most recent minerals in lodes, and are never found at any depth. Apatite, allogonite, amblygonite, are certainly to be excepted, together with some others.

General Results.—The true anhydrous silicates occur, for the most part, as constituents of rocks, less frequently in lodes. In the latter case they indicate a very great age; garnets, felsites, amphiboles, pyroxenes, &c.; but some few silicates occur either chiefly or only in lodes and "kalkstöcken," *e.g.*, skapolite, epidote, zygodite, &c. Hydrated silicates occur almost only in lodes and vesicular cavities. Quartz, calcite, (including limestones) and dolomite, are not only important constituents of many rocks, but are uncommonly frequent in lodes as well as many other members of the spar group, barytite, fluorite, and brownite. With regard to quartz, it is very remarkable that it is almost entirely absent in those lode formations which cut rocks consisting of silicates without quartz. The quartzy sandstone fragments inclosed in decidedly igneous rocks is fritted (*Buchite*), but lode quartz has never been found in this state; a fact which leads to the opinion that it has been formed in the wet way, and indeed that it has frequently been brought from the interior of the earth by steam, and derived from the adjoining rocks by extraction. The not unfrequent disintegration of the adjoining rock speaks in favour of the latter view, as does the presence of quartz in the small vesicular cavities of the amygdaloid rocks. In this respect lodes and vesicular cavities have a great resemblance.

Some minerals which occur in lodes, especially oxides, are not unfrequently accessary constituents of crystalline rocks, both sedimentary and eruptive, *e.g.*, magnetic iron, titanium, tin ore, dyschorite, and tantalite. Some other oxidized minerals are still more frequently met with only in lodes. Manganese, brown iron ore, red iron, specular iron, have never been found in any crystalline rock. The first has never been found in a vesicular cavity, nor indeed the latter, with the exception of some few rare minerals containing repoxide of iron. Manganese, tin ore, wolframite, &c., have never been found with a zeolite, and in the study of the paragenetic relations of minerals negative facts must be taken into account as well as positive ones. It cannot be denied that the minerals disseminated in rocks, such as pyrites, especially ferruginous pyrites, and perhaps some kinds of glance, and even zinc blende, occur principally in the proximity of lodes. It has already been shewn that some of these phenomena are owing to the presence of lodes, to impregnation, but it is also probable that such impregnation has taken place when we are unable to detect any direct evidence of it. For example, the fact that such pyrites have never been found in vesicular cavities, appears to support this conjecture. It is indeed possible that not only are tin ore, dyschorite, ferruginous pyrites, impregnations of this kind from lodes, but likewise gold and copper. In any case, rocks containing useful minerals disseminated ought to be closely examined for lodes, and there is every possibility that when found they may contain the minerals in a more concentrated form than the rock. Granite containing disseminated tin ore has, when lodes have been found, been advantageously worked for tin. It is probable that, at some future time, an available copper lode may be discovered in the red amygdaloid of Zwickau, which contains plates of metallic copper of considerable extent, though not abundant enough for working. It is probable that a discharge of cupreous liquid from lodes into the partly eruptive amygdaloid, as at a later period such a discharge must have flowed into the sea, from which the rock of the Zechstein formation originated. In North Carolina lodes bearing gold have been discovered and worked, besides the gold in alluvial deposits, and partly imbedded in water-worn fragments of rock.

Even in the chemical composition of minerals there is a remarkable association. Almost all minerals containing lithia have an admixture of soda and potash; minerals are seldom free from soda. Most galenas contain at least traces of silver. But in the association of minerals having no chemical relation, resemblance is still more frequent. There is no titanite which is not accompanied by an amphibole, scarce any epidote without amphibole and quartz. Rutile is never without quartz, while it is never associated with titanite. From such facts it is possible to decide with certainty whether a rock is diorite or syenite, or diabase or dolerite, for neither of the latter would contain titanites or epidotes. Still more striking are the associations in lodes in regard either to the chemical elements, or to the lode minerals, irrespective of their chemical resemblance. Thus, for instance, the association of cobalt, nickel, arsenic, and bismuth—of zinc, lead, and silver—of antimony, scheel, and even molybdenum—of antimony and gold.

The association in some instances of large masses of barytite and fluorite is not only remarkable in itself, but because it contains several of the above mentioned groups of minerals, in which the metals are in analogous chemical combinations, carbonates being abundant. The varieties of pyrites, glance, blende, are remarkably frequent in it, and also the arsenio-sulphurets and arseniurets, perhaps also with antimony. It is these minerals chiefly which gave to the lodes their distinguishing characters in their original perfect state. To these must be added several of the above mentioned oxidized minerals, such as tin ore, dyschorite, &c., while other oxides are products of decomposition. In the upper part lodes certainly present a physiognomy differing from that of their original state, because the products of decomposition are situated there, sometimes predominating, and either in their own forms or as pseudomorphs. Adding to these the products of gradual alteration, such as steatite, it is evident that the present condition of certain depths of lodes varies greatly from the original. Substances coming from the surface have certainly taken part in the decomposition, and the influence of the adjoining rock is not to be doubted.

The substances found in vesicular cavities show what may result from lateral secretion alone ; but there is a great difference between these substances and those found in lodes. What has been said of these latter is sufficient to lead to the conviction that the greater part of them must have come from the interior of the earth, and not from the side or above. We may indeed imagine the oxides to have been brought up in a solution as springs, and precipipated by sulphuretted hydrogen and arseniuretted hydrogen, but it is more probable that they were introduced into the fissures in this form, and the question may justly be raised whether there has not been more introduced into the rocks from lodes than from the rocks into the lodes. We have already seen how astonishing is the action of a younger rock upon an older. The old belief of miners that the lodes are richer at greater depths has therefore, in general, a good foundation. It is possible that where considerable decomposition and alteration has taken place much has been carried away from the lodes through fissures, in consequence of which they may very probably be more valuable at a depth than where the minerals are no longer in the original state. It is, moreover, in all respects, easily conceivable that the sulphuretted and arsenious minerals should be farther from the surface than those which are oxidized and acid, for the atmosphere, and as regards the phosphates, the organic world must have acted upon them, and they are readily decomposed.

Hitherto only the normal conditions of association in lodes have been considered. There are, however, particular abnormal phenomena observed at the intersection of lodes containing substances not naturally associated; and where a lode traverses different kinds of rocks, or has the terminal planes for saalbands. These circumstances have a uniform connection with the richness of the lodes. This appears to be determined partly by the nature of the adjoining rock. Lode systems generally appear to exist in rocks, where they are considerably fissured, even where the fissures have been filled again. This appears very natural. It is very frequently observed in mining operations that, even when a lode has become poor or altogether deficient in ore, it again becomes richer when other fissures having a certain position and direction run into it, even when they are themselves empty; and when they run out from the lode, or it branches off, it is a sign that it will soon cease to bear ore. The opinion that the points of intersection are particularly rich has, in general, been abundantly confirmed by experience. There are, however, some exceptional instances. Minerals appear to have been deposited where there was a vacant space for them. An alteration in the composition of the minerals composing a lode indicates the proximity of another lode traversing it. Thus the occurrence of copper pyrites, fahlerz, and copper-blende, in the pyritic lead and zinc formation of Freiberg, generally indicates its intersection by a barytite and fluorite lode, and after this is passed the usual minerals are again found at a short distance. It is likewise considered that a lode will yield better the greater the quantity of water found in working it. The abundance of water and the richness of the lode are probably both results of the fissured state of the rock. The absence of ores in lodes appears likewise to be connected with a certain set of conditions.

The intersection and junction of lodes, and the fissured state of the rock containing them, are very important, but the mineralogical character of the adjoining rock is perhaps still more intimately connected with the richness of the lode in ore. This may be owing to very different causes. But there are two circumstances which may throw some light upon the subject—(1.) Certain beds of the adjoining rock are metalliferous, *e.g.*, the Fallbänder of Königsberg, the Rücken of the cupreous slate, &c., and substances may have been introduced from them into the veins. (2.) Some lodes appear particularly rich in ore where they cut certain rocks, *e.g.*, argentiferous-quartz formation in gneiss and mica-slate of different aspect in the Freiberg district, and various mica-slates in the Johanngeorgenstadt district, lodes in limestone and lodestone in England. There would appear to have been a kind of attraction exercised by certain rocks. The collection of facts of this kind should be attended to as it has a practical value for miners. In a scientific point of view, likewise, it appears to indicate that there may be peculiarities in districts containing ore lodes which have not yet been reduced to general rules.

In conclusion, Professor Breithaupt remarks that he considers it in the highest degree probable that electro-magnetic and other molecular agencies have been concerned in the deposition and arrangement of minerals in lodes, but in the absence of the necessary data, it is at present impossible to say to what extent this may have been the case, whether generally or only in particular instances.

B. H. PAUL.

On Coal—The Nature of the Plants forming Coal—The changes produced by Chemical Action and Compression—Associated Mineral Matter—Origin of Coal. By Professor HARKNESS, Queen's College, Cork.

In order that an idea be arrived at concerning the nature and origin of the substance which forms the great mass of our fossil fuel, it is necessary that such a definition of this substance be given as shall, as far as possible, embrace all the circumstances and conditions under which coal presents itself, and also such as should give some idea as to the nature of the substance itself. Such a definition may describe coal as being chemically altered and compressed vegetable matter, associated with more or less of earthy substances, and capable of being used as fuel. This definition embraces not only the nature of coal, but it also includes all the modifications to which fossil fuel is in a great measure subject. It also presents the inquiry concerning the nature and origin of coal in three aspects,—1*st*, The nature of the plants from whence the vegetable matter constituting coal was derived; 2*d*, The changes which these plants have undergone in consequence of chemical action and compression; and 3*d*, As regards the associated mineral matter—in what manner this has become combined in coal, and in what respect it tends to modify the character possessed by this substance.

The nature of the Plants forming Coal.—To commence with the nature of the plants which have furnished the vegetable matter of coal, we might be led to inquire into the flora of the carboniferous formation generally, as the knowledge of this flora has been derived principally from the deposits interstratifying the coal seams. Certain peculiar forms of vegetables, however, make their appearance in great abundance in connection with coal, and these appear to have supplied to a very great extent the organic matter entering into the composition of this material, and some knowledge of them may suffice so far as concerns coal. There is another circumstance which, when taken into consideration, renders this subject less profuse than it would otherwise be, and this is, that the conditions which obtained during the growth of the plants which have supplied this substance seem to have been of a somewhat local nature, and such as furnished a habitat suitable for certain kinds of plants. The evidence which the coal formation affords tends to the conclusion that the deposits of coal itself, and also those with which it is immediately intercalated, are of an aquatic character; but this aquatic character, so far as respects coal, was the result of an estuary, or some modification allied thereto. We are, therefore, rather induced to inquire, what was the nature of the plants which occupied such a habitat during the coal epoch, than what forms of plants clothed the surface of the earth when the carboniferous strata were being deposited?

Mr Witham, in his work on the internal structure of fossil plants, p. 9, observes, in connection with this matter:—"If we take it for granted that the coal-seams are formed by the deposition of vegetable matter produced either on the spot where it is now found, or brought from a distance, we can easily offer an explanation of the differences found to exist between the coal fields of England above alluded to (referring to the abundance of ferns in these coal measures when compared with those of Scotland), and the Scotch basins in regard to the occurrence of fossil vascular cryptogamic plants, and their impressions. In a flat country like Northumberland, Durham, and Yorkshire, surrounded by mountains of no great elevation, from which a supply of more perfect wood could have been obtained, the vast mass of carbonaceous matter deposited must have resulted from vegetables growing on the spot, and this may have had its origin in a great measure from the vascular cryptogamic plants which a marshy country, such as it might have been, would have produced in great abundance, and with a luxuriance of which we can now have but little conception, unless we contemplate the profuse vegetation of the tropics. The Scotch coal basins, on the contrary, seem to have been formed in large inland lakes or hollows, produced by the expansion of immense bodies of water. In these lakes or hollows, the produce of vast forests, which may have existed in the valleys of the high regions, may have been carried down by eddies and currents. As these trees had grown at great elevations, most of them carried along by the great rivers and their tributary streams, may have consisted of coniferæ, or plants possessing a structure closely allied to that of our present pines." With respect to these remarks of Mr Witham, which tend to the conclusion that coal-seams may have been derived from different forms of vegetation, and in which it is inferred that the Scotch seams have been the result of drifted plants, the latter a circumstance which the nature and arrangement of the seams does not support, we have the inference of the existence of a different flora under different circumstances during the same time,—a flora which may be regarded as occupying the high lands, where conditions obtained such as were not favourable to the production of coal. The evidence of the existence of this more elevated flora during the coal epoch is principally obtained from the sandstone strata of the coal measures,—a series of deposits which have had their origin in water having a considerable power of transport; and the position of the fossil plants which are found in them leads to the conclusion that there had been, in a great measure, different vegetables amongst these plants, or some hard-wooded trees, to which Witham has applied the generic term of Pinites, and these seem to have considerable affinity to the modern araucaria. These hard-wooded trees appear to enter very sparingly into the composition of coal, and their existence during this epoch in no way affects the question as to the nature of the plants which constitute the mass of fossil fuel.

So far as coal affords us evidence in the form of plants which retain their external aspect, this, for the most part, consists of portions of sigillariæ and nearly allied forms; and the circumstance that the underclays of coal-seams contain such an immense quantity of stigmariæ, the roots of sigillariæ, and kindred plants, supports the inference that such plants entered largely into the composition of coal. —See a recent Memoir published in the *Quarterly Journal of the Geological Society*, vol. x., where Mr Dawson describes in detail the measures which make up the coal fields of Nova Scotia, and in these coal measures there occur many seams of fossil fuel, which, in almost all instances, he attributes to the growth of sigillariæ; and as respects coniferæ, he remarks, that "trunks of this description occur in the sandstones both in a carbonized state, and petrified by carbonate of lime. It is observable, that they are most abundant in those parts of the section where the swamp conditions of the production coal measures begin to disappear, and where drifted plants predominate over those which have grown *in situ;* in other words, in the sandstones above and below our section." "The prevalence of coniferous trees, as drift-wood, in the sandstones above and below the coal measures, is probably to be attributed to their capability of floating for a long time without their becoming water soaked and sinking, though it may also indicate that their principal habitat was farther inland than the sigillariæ swamps."

Altogether from the evidence which all the coal deposits afford, it would appear that coniferous trees do not enter largely into the composition of fossil fuel, but that this is produced from sigillariæ, and probably also, in part, from other abundant coal plants, such as calamites and lepidodendra. A knowledge, therefore, of the internal organization of these forms would lead us to some idea concerning the vegetation which has furnished the organic matter constituting coal. Probably the most concise and perfect account we possess of the internal structure of sigillariæ, calamites, and lepidodendra, is to be found in Dr Hooker's observations in the 2d vol. part ii. of the Memoirs of the Geological Survey. Concerning the first of these plants, viz., sigillariæ, from the examination of internal structure of the specimen by A. Brongniart, called by this botanist *S. elegans*, it would appear that this form consisted to a very great extent of cellular tissue, in the centre of which was a narrow vascular sheath, which bore but a very small proportion to the cellular mass in which it was enclosed; and this vascular sheath, on transverse section, appears somewhat akin to gymnospermous wood. With regard to sigillariæ, Dr Hooker remarks,—"The great bulk of sigillariæ seems to have been inimical to the preservation of their tissue, the process of decay being generally effected on a grand scale in the substance of a plant evidently almost entirely composed of a lax tissue. The remains of a central column are, however, sufficiently obvious in the upright stems of many sigillariæ; these have been called 'Endogenites,' are scarcely two inches in diameter, and are generally obliquely placed in the substance of the specimens, five feet and upwards in girth. That this slender column represented all the vascular tissue of this plant I cannot doubt, from examination of stigmariæ, whose vascular column often assumes the same appearance."

Concerning the second tribe of plants which seems to enter into the constitution of coal, viz., calamites, we are not in a position to judge of their nature, since they have left no traces of their internal structure among the many specimens which occur in the coal measures. From their generally compressed state they must have had a lax, probably succulent tissue, composed for the most part of cellular tissue, as distinct from vascular. Of the third form lepidodendra this seems to have been nearly akin to the sigillariæ; and on this matter Dr Hooker observes, "that the sigillariæ were allied to lycopodiaceæ is evident, their tissues and seaming being very like those of lepidodendra, in which, however, there is but one series of zone of vascular tissue. In both the great mass of the woody axis is formed of large tubular vessels, identical in structure; and in both fascicles are given off from the central mass to the scars on the circumference, which fascicles consist of slenderer tubes than the axis does. In lepidodendra there are no medullary rays, the vascular zone being continuous, and surrounded by those slender vessels from which the fascicles diverge and run to the scars." In this form the cellular structure, as distinct from the vascular cylinder, prevails even to a greater extent than in sigillariæ, as may be seen in Witham's plates of the internal structure of the *Lepidodendron Harcourtii.* It would therefore appear that the three forms of plants which enter most largely into the composition of coal are to a very great extent made up of simple cellular tissue, and that these have been succulent plants, very brittle in their nature, since we often find the lower portions in such a state as would result from the sudden snapping off of the stems; and from the internal structure of sigillariæ, calamites, and lepidodendra, we may regard the vegetable portion of coal as being, to a very great extent, the cellular tissue of these forms of vegetation compressed and chemically altered.

The changes produced by Chemical Action and Compression.—The next question which presents itself is, what are the changes which the vegetable matter, entering into the composition, has undergone? From the various analyses of different coals, it would seem that the amount of change produced by chemical action has been very different in the several varieties of this substance. In that description known in England under the name of cannel, and in Scotland as parrot-coal, we have a greater amount of hydrogen than usually occurs in ordinary coals. In the caking and stone varieties of common coal there are also differences in the gaseous constituents, and in anthracite, we have a form far removed, so far as chemical constitution is concerned, from either of the other descriptions of this substance. These differences, in the nature and amount of the gaseous constituents, lead to the inference that they have originated from the various amounts of decomposition which the vegetable matter forming coal has undergone; and it would appear that the decomposition of the vegetable matter has been more or less affected by some influences which have in some instances checked, and in others advanced, the chemical changes, acting upon the vegetable tissue which form the organic portion of coal. If we divide coal into three groups, namely, cannel or parrot-coal, ordinary coal, including caking and stone-coal, and anthracite, we express not only a difference in aspect and constituents, but likewise indicate that these three groups have been derived from vegetable matter which has undergone three different amounts of decomposition. With regard to the first of these groups, cannel coal, we have in this a greater amount of hydrogen than obtains in ordinary coals, and this greater amount of hydrogen must have arisen from this principle, as continued in the original tissues of the plants which have furnished the organic elements of this substance; and this circumstance leads us to conclude that the vegetable matter forming cannel has been less subjected to chemical decomposition than that in ordinary coals. The aspect of this substance, which is generally less shining also, supports the inference that the amount of change produced on the organic constituents is less than usually prevails in other coals, and therefore we must regard cannel as being the result of vegetable matter which retains more of its original constituents than other coals. As respects ordinary coals, these are intermediate in their character, so far as regards hydrogen, between the cannel and the anthracites. They seem to have parted with a considerable portion of their hydrogen, as this originally formed portions of the plants from which coal is derived; and hence we have them possessed of different properties and amount of constituents, in some instances affording a considerable amount of hydrogen, and in others only a small quantity, approaching in their nature to the anthracites, where we have the hydrogenous principle developed only to a very small extent.

Taking, therefore, the elemental principle hydrogen, as a criterion from which to draw deductions concerning the state in which the vegetable matter forming this substance is, we should infer that in those which retained the greatest amount of this we have the tissues nearest their original condition, and we should consequently conclude that in cannels this vegetable matter is nearest its original state; while in ordinary coals it is more changed, and in anthracites it has so far lost its original character as to retain but a small portion of this principle. The result of this loss of hydrogen, and the change which the vegetable matter would undergo consequent thereon, would induce us to expect that compression would be varying in its effects in proportion to the modification which the vegetable matter has been subject to, more particularly when no mineral matter has supplied the place of the organic constituents of the vegetables, a circumstance which seems to have been ordinarily the case with coals. In cannels, therefore, and in other coals abounding in hydrogen, where the constituents of the plants are nearest their original state, and where we may infer that the cellular structure has only been in part obliterated, the effects of compression on this would be less than when the vegetable matter had so far changed its nature as to be almost converted into carbon. We may therefore infer that the results of compression would be modified according to the condition of the substance compressed; and taking this as a means of judging of the state and effects of compression, we might conclude that cannel was better able to resist compression than ordinary coals, and that, consequently, the effects produced thereby are less than on this form of fossil fuel, a conclusion which we shall find some matters connected with this substance, to a very great extent, justifies, more particularly when we come to consider the structure which this presents.

The Associated Mineral Matter.—Having seen the natures of the vegetable structures which enter into the composition of coal, and how this may be variously modified by chemical changes and compression, we are next led to enquire into the results which are produced on the compressed and chemically altered vegetable matter by the addition of earthy substances. These earthy substances make their appearance as ashes, or in some modified form of solid products, which remains after combustion; and as the amount of ash varies greatly in different coals, so does the amount of earthy matter which in part forms this substance. The numerous analyses of the various coals which have been ascertained, would occupy too large a space, and therefore a few of these may be given, showing how greatly the quantity of earthy matters varies. With regard to cannels, those which occur in the Scotch coalfield afford the following results:—Rochsoles 17 to 32 per cent., Methill 18 to 22½ per cent., Boghead 20 to 25 per cent., Dryden 25½ per cent., Balbardie 26 per cent., Hillhead 27 per cent., Capeldrea 20 to 30 per cent. In the case of the English cannel coals, these also vary greatly in the amount of earthy matter which is contained in them. One of these, the Hoo cannel of Wigan has, in the Botton Hoo, 22 per cent., and in the top Hoo as much as 40 per cent. The common coals also vary greatly in the amount of earthy substances which enter into their composition, the Scotch varying from 10·70, as in the case of the Wallsend Elgin, to 3·10 in the Dalkeith coronation seam. The same difference prevails among the English ordinary coals, and also in those which are obtained from the South Wales coalfield. However, as respects ordinary coals, these afford a smaller amount of ash than is procured from the cannels. Many coals which are in no way possessed of the characters of cannel coal, in some instances furnish a very large quantity of ash, approaching to 30 per cent.; and when this prevails to such an extent, it materially modifies the character and value of coal. The compound nature of coal prevents us regarding this as a mineral, in the strict sense of the term, however the popular idea may be expressed on this subject; and being of a compound nature this substance passes from coal to shale in proportion as the mineral matter with which the organic constituents of coal is associated predominates; and when this mineral matter prevails to such an extent as to render this compound of chemically altered and compressed vegetable matter, associated with earthy substances, incapable of being used as fuel by itself, it should be regarded as a coaly shale; a substance which has, unfortunately for science, been termed bituminous shale. Between coals and shales, therefore, there is an insensible gradation, and the point where the one ends and the other begins can only be determined by ascertaining whether this compound substance can be used for the ordinary purposes of fuel.

There is another circumstance which in part serves to determine between hydrogenous coals and shales; this is the sp. gr., which, in the former, rarely exceeds 1·4, while in the latter the sp. gr. extends from 1·8—2·6, but in the case of coals which contain much iron pyrites this principle is scarcely applicable; on the whole, however, coals possess a less specific gravity than shales.

Origin of Coal.—Having seen the nature of coal, how it is a compound substance—being, in part, composed of organic, and in part of inorganic matter—we are next led to enquire under what circumstances this originates; and, in order to arrive at any satisfactory conclusion on this matter, we have to take into consideration some of the peculiar features which occur in the strata intercalated with the coal beds; and also what phenomena the coal itself affords, which will assist us in our inferences concerning the immediate causes from whence this substance resulted. One of the constant concomitants of coal is the presence of sigillariæ rootlets, which are met with in great abundance in the floors on which this rests. The nature of these, and the strata in which they occur, lead to the inference that they were the roots of plants which flourished in an aquatic habitat, and, as we have already seen, there is every reason to conclude, that the plants, of which these formed a part, enter largely into the composition of coal; so it would appear that the primary origin of this substance was aqueous. The conditions under which the plants, from whence the organic matter was derived, flourished, appear to have been rather of a nature akin to such swamps as were to a very great extent covered with water, than to anything in the form of peat-bogs; to such swamps as occur in the deltas of some of the larger rivers; and there are many circumstances which support the opinion that the stems of the trees, as well as their roots, were, to a considerable extent, covered with water.

With regard to the phenomena presented by the coal itself, these, in some instances, are of an important nature, and afford evidence of considerable interest concerning the origin of this substance. With respect to the structure of coal, this, in some cases, is very manifest; but it is in general only in such coals as have not undergone a very great amount of chemical changes and compression that we can expect to find this in its most perfect state.

The first evidence we possess of the internal structure of coal is from the sections of Witham, figured in plate xi. of his work on the internal structure of fossil vegetables. Concerning the sections here given, Nos. 6, 7, 8, and 9, leave no doubt of their being portions of the vascular sheaths of probably a coniferous tree. But of sections 4 and 5, there are very great doubts whether these can be strictly regarded as representing vegetable tissue. Of these sections, which are from Lancashire cannel, Witham observes, that "the appearances are so undecided, that although I should be inclined to consider them indicative of a monocotyledonous plant, I shall not venture at any conjecture respecting them." The structure which the Lancashire cannel usually presents is that figured by this author, and many of the Scotch parrots afford the same appearances when sliced and magnified. But there is one circumstance to be considered which militates strongly against the idea that this can be regarded as true vegetable tissue, and this is, that among the many plants which have been met with in the coalfields, retaining internal structure, none of these furnish us with tissue bearing any affinity to this structure as generally seen in cannel. The structure, as above referred to, appears to me to be merely the results of structure, and not what is or was regarded by Witham merely monocotyledonous tissue. From an examination of many cannels, I am inclined to regard the circular spaces figured as having originated in the decomposition and total destruction of the vascular sheaths of minute rootlets of stigmaria, which have totally disappeared, leaving in the centre of these a small portion of black coaly matter, the remains of that portion of the cellular tissue which represented the pith, and surrounded by other coaly matter, the remains of the external cellular portion. Such a conclusion would lead to the inference, that the vascular sheaths sooner became subject to change, and were separated from the plants of which they originally formed a portion—a circumstance which we shall find other phenomena afforded by coal tends to show was the case. From what has already been said concerning the nature of the vegetable tissue which occupies so large a portion of the plants forming coal, we should be induced to infer that, when their substance retains structure, this would be present in the form of cellular tissue; and such is really the case with such of the Scotch cannels as are most hydrogenous, and have been subjected to the smallest amount of compression and chemical alteration. Where the amount of chemical change has been considerable, as in the ordinary Scotch and Lancashire cannels, the cellular tissue has disappeared, and nothing remains to show the original structure of the vegetation from whence coal has been derived, save the hollow cylinders from whence the vascular portion of the plants have escaped; but even in this case, the vegetable matter has been in such a condition as to resist the compression which would otherwise have obliterated these cylinders, as is the case in ordinary coal, which has undergone the greatest amount of chemical change and compression, and which, in general, has, in consequence thereof, lost all traces of the original structure of the plants which compose it.

Besides the cellular tissue, the remains of which can be detected in the least altered Scotch cannels, we, in some instances, meet with the vascular tissue manifesting itself in coal. When this is the case, this vascular tissue does not occur in the cylindrical form which it had when forming the sheath of the original plant, but it is seen in a fragmentary state. This portion of the original tissue of the plants which compose coal, is generally found having an aspect resembling charcoal, and is, in some localities, known under the name of "Mother Coal." In ordinary coals, it is frequently seen in the form of a thin silky coating, covering some of the surfaces of the coal, from which it may be detached by a needle, and, when examined by a microscope, it affords the usual appearances presented by this portion of the vegetable tissue. In cannel coals, it is commonly seen in a form which has somewhat of a wedge shape, embedded in a fragmentary state in the matter of the cannel itself. There can be no doubt that, when it occurs in this state, it has been *floated*, and afterwards been embedded in the mass from whence resulted the cannel. The form in which we have this in cannel, namely, as wedge-shaped fragments, affords us evidence of the manner in which this portion of the vegetable structure becomes separated from the cellular portion, leaving the space which it occupied in the form of a hollow cylinder. These wedge-shaped fragments are the portions of the vascular cylinder, which are separated from each other by the medullary rays, and when decomposition takes place, these medullary rays give way, and the vascular tissue, which is arranged as a series of wedges round the pith, being no longer supported, floats away, if there be water, and these floating fragments in time become water-logged, and falling to the bottom become embedded in the mass of matter forming the coal. This mode of occurrence of the vascular portion of the coal is not confined to the coal seams of the true carboniferous formation; but it has been also met with, according to Dr Hooker, in the oolitic coal of Virginia. The manner in which this "Mother coal" is associated with the cannels and ordinary coals supports the conclusion, that coal has been formed under water, otherwise it would be difficult to account for this substance occurring in fragments embedded in the coaly mass. There is a substance which is nearly allied to mother coal, except that it has formed the vascular sheath of other forms of plants than those which enter into the composition of coal, and this occurs in the calc grits of the Yorkshire oolites, in a somewhat similar form, and consists of portions of the vascular system of the flora of this epoch, which, like the "Mother Coal" of the carboniferous formation, have floated about; but, in the oolite, after they had become water-logged, instead of sinking among a mass of vegetable matter, they became mingled with sand, and now appear as fragments of coal in sandstone strata. The occurrence of fossils, in a comparatively perfect state, in the cannel seams, also supports the conclusion that this substance has been deposited under water, since we not only find plants embedded therein, but likewise the remains of fishes in a fragmentary state, as is the case with the Wigan cannel, which often contains these remains in the form of iron pyrites; and these, which consist of teeth, jaws, and scales, more or less detached, are in such a position that they must have been embedded in cannel through the transporting agency of water. The Scotch cannel seams, in many instances, afford remains of fish under the same circumstances; and in the bastard cannels of Bradford, near Manchester, these ichthyic remains are very abundant. Among the cannels of Wigan, shells of the genus modiola occur, embedded in the mass; and this, too, confirms the opinion, that this substance had its origin in some way connected with the influence of water, and is antagonistic to the idea that the coal seams have arisen from the same causes which now produce peat-bogs. Ordinary coals rarely afford remains distinct from the mass of the coals, as already stated, and this may have resulted from the amount of decomposition which these latter may have undergone, having effaced all traces of organic forms, both as regards structure and appearances. In such of the Scotch cannels as contain a large amount of hydrogen, and which have been subject to only a small amount of change from compression and chemical alteration, as those of Boghead and Methill, we find stigmaria, both in the form of roots and rootlets, in a more perfect state of preservation than occurs in ordinary coal, or even in other varieties of cannel. These present such appearances as would result from the circumstances under which they have grown, and in which they now occur, and they induce us to conclude that the cannels which afford them were original—a mass of vegetable matter associated with mud, which furnished all the necessary condition for a luxuriant vegetation; and these cannels, along with the whole of the members of the coal group, tend to the inference that coal originated under the influence of water, and that it was, when being formed, rather similar to the subaqueous swampy mud which prevails near the mouths of many of the intertropical rivers, than to the peat-bogs of the higher latitudes.

On the Cultivation of Tea in the District of Kangra. By WILLIAM JAMESON, Esq., Director of the Botanical Gardens, North West Provinces, India.

When the Most Noble the Governor-General visited the Kangra valley, there were only two small nurseries, formed from plants imported from Kumaon, in the localities distant from each other, the one at Nagrota, and the other at Bowarnah, in the Pahlum valley, in order to shew that Tea could be advantageously grown.

In these sites the plants are growing with the greatest luxuriance, hundreds being five and six feet high, and from them, last season, 227 lb. of teas, Pouchong, Souchong, and Bohea, were prepared, samples of which have been forwarded to Calcutta, for transmission to the Honourable the Court of Directors, in order that their quality may be tested by the home brokers. In addition to the teas, the nurseries yielded about a ton of seeds. The luxuriant growth of the plants induced his Lordship, the Governor-General, after personal inspection, to sanction the formation of an extensive plantation ; and for this purpose, I selected the waste plain of Holta, at the base of the Chumba range, in about north latitude 32°, and longitude 76° 30′, a large, highly-undulating tract of waste land, bounded on either side by two considerable streams, the Awa to the east, and the Nigal to west, which take their rise to the north in the snows of the Chumba range. These rivers completely command the plain ; and their waters can, at any time, be made available for irrigation, when a droughty season occurs, and it is deemed necessary.

The plantation is from 3500 to 4000 feet above the level of the sea, and its soil consists of a rich black vegetable mould, varying in thickness from two feet to six inches, which rests upon a sub-soil of stiff red clay. In this clay boulders of granite abound, forming a characteristic mark of this valley. These boulders occur of all sizes, varying from fifty feet in height, and three hundred feet in circumference, to the size of a pea, and in every locality ; and to the alkali in the felspar which they contain, is owing, in a great measure, the fertility of the soil. In all places the drainage is good ; the whole land being highly undulating, and dipping under an angle, varying from 4° to 25°. The plain (if such a term can be applied to a tract of land consisting of a series of small hills and valleys, spurs issuing from the Chumba range and dipping to the south), is of great extent, almost entirely waste, and used by the baeparees for grazing their cattle. On it but few trees are met with, consisting of the Cheer (Pinus *longifolia*), oak (Quercus *incana*), ayer (Andromeda *ovalifolia*), &c., characteristic of considerable altitude.

Here snow falls annually during the months of December and January, and lies for some length of time. The tea already prepared, the produce of leaves of the Nagrota and Bowarnah nuseries, is very highly flavoured; and as the altitude of these places is much below Holta, I doubt not but that this plantation will produce teas of a very superior description. The Chinese tea manufacturers, now employed there, state that the leaves grown in the Kohistan of the Punjaub, are superior to the produce of Kumaon and Gurwal for manufacturing teas; and they speak from experience, as they have been working in both places. With their opinion I coincide, and attribute the advantages to the heavy falls of snow and rain which annually take place in the cold weather in the Kohistan. In China, in the northern districts, where snow continually falls in the cold weather, the teas are found to possess the highest aroma, and, probably, the same will be found to be the case with the Punjaub teas, and they will thus command the greatest sale and highest prices. But before this can ever be realized, it will be necessary to procure first-rate tea manufacturers, as the men there located, though good workmen, are not first-rate. One of the sets, therefore, now being imported, under Mr Fortune, from China, might with advantage be sent to Holta.

Future prospects.—At Holta, about 100,000 young plants have been transplanted, and a ton and a half of seeds sown, twenty-five maunds of which were the produce of the valley, and the remainder imported from Kaolageer and Kumaon. From these there will be a vast return of young plants; and in a short time, I trust, to be able to plant the whole of the land, amounting to about five hundred acres, taken in for the tea plantation.

At the present moment, the great crops in the Kangra valley are rice, wheat, barley, and sugar; a third of which is exported to the plains. But the time is not far distant, when the canals, now in progress in the Punjaub, are opened, for us to expect that this market will be closed, or rather, that the cultivators will not be able to grow grain at a sufficiently low rate in the Kohistan, to compete with the produce of the plains. At the present moment, two-fifths of the Punjaub are lying waste, partly owing to the bad management of former governments, and partly owing to the want of population. Now, security to life and property prevail. Natives are encouraged to settle, populate the country, and break up the waste lands ; and not, as in former days, look to aggression for aggrandizement. The Punjaub is eminently an agricultural one, and with the impetus which has, within the last few years, been given to cultivation, it must shortly become the granary of upper India. At present the vast works going on, and the immense demand for foreign labour, tend to keep up the prices of grain ; once, however, let these be completed, and the tens of thousands of acres irrigated, which the canals are intended to do, the markets will be so glutted with home produce, as to exclude all foreign competition. Even now the cultivators in the Kangra valley declare, that they export their grain at a small remunerating return, and the baeparees, or men who carry the grain (and to the credit of the authorities, be it stated, that the roads are in such admirable order as to admit of camels and bullocks being used), complain that their trade is scarcely worth keeping up, owing to the small hire that they receive, caused by the settled and firm government prevailing in the Punjaub, giving security to property, and inducing vast numbers to look to the plough for their livelihood, instead of, as in former days, to the sword. It, therefore, requires no foresight to predict that the Punjaub will become the great granary of upper India, and exclude imports of grain from all other quarters. Such being the case, grain will not be worth exporting from the Kohistan. This will be so far satisfactory, as it will greatly lower the prices in the hills, and thus enable the enormous number of idle men, estimated by Mr Bayley, deputy commissioner, at upwards of 10,000, to get food at a low rate. These men, the remnants of the Sikh army, and of bands kept up by the petty Rajahs in the Kohistan, despise the plough, and consider it derogatory to their caste, to be engaged in ploughing ; though, at the same time, they will willingly work with a phourah or spade. In this manner alone the introduction of tea into the Kohistan is likely to confer a great benefit on the people by ensuring work to thousands who might otherwise look for a livelihood in rapine and plunder. For employment at Holta, hundreds of Rajpoots have presented themselves, and are willing to be employed, provided that they were not obliged to handle the plough. The plantation, in several places, admits of the plough being used, but the greater portion must be broken up with the Indian spade or phourah, owing to the high inclination of the land. I have, therefore, purchased only a few bullocks; moreover, as soon as the land is planted with tea plants, the labour will be chiefly manual. Under these circumstances, tea cultivation will, no doubt, become popular with a class who have hitherto despised field labour. In Kumaon and Gurwal, high caste Rajpoots and Brahmins willingly engage themselves as servants in the plantations. So in the Kohistan of the Punjaub, it will not be long before employment of a similar nature becomes equally popular, and the men who have been in the habit of looking to the sword for their livelihood, find a more certain and profitable work in the phourah or spade.

Nor is land, fitted for tea cultivation in the Kohistan, limited. The Kangra valley (divided into three portions—the western or Riloo valley, the middle or Kangra valley, properly so called, and the eastern or Pahlum valley), is about sixty miles long, and averaging ten miles in breadth; and of it, at least half is well adapted to tea cultivation. Much land, well fitted for the same purpose, is to be met with in Kooloo, Mundee, &c., and throughout the western hills. By Captain Hay, assistant commissioner, Kooloo, a small tea nursery has already been formed at Kanghur, and the plants are growing with the greatest vigour, many of them being four or five feet high. Further to the westward, in the Hazara country, a tea plantation is being formed by Mr Carnac, deputy commissioner, Sind Sagor District, under the auspices of the commissioner, Mr Thornton; and his labours will, no doubt, be attended with success. Moreover, and this is a fact of the utmost importance, the inhabitants to the west and north-west are a tea-drinking nation, large supplies being imported from China to supply their wants. So that here there is a market at hand, and all that is required to make a large demand for Punjaub teas, is a low rate of sale. A foreign market is not, therefore, wanted, at least for a time. In addition, the Kohistan of the Punjaub, and the north-western frontier generally, possess extraordinary capabilities through means of their rivers; as by them teas can be conveyed, at a small rate, to Kurachee and Bombay, and from thence shipped to the European markets. The roads, too, in the Kohistan, as already stated, are admirable, and admit of beasts of burden being employed in the carriage of teas to the river ghats, a point of great importance. In Kooloo, the poppy is at present largely cultivated for preparing opium for exportation to China; and, I believe, that I speak within bounds when I mention, that more than a fifth of the land of that province is thus occupied. At present the demand for that drug is great, but how long that will continue is a question; and were the value of opium greatly to decrease, which may, at any time, occur by the cultivation of the poppy being legalized in China, that country being as fitted for its cultivation as India, the whole of the land thus employed in Kooloo would become available for tea. To provide against such a contingency, a tea plantation might with advantage be there introduced, and on a sufficiently large scale to work a factory with success. In the Simla District, the Government land is in too small quantity to admit of such an arrangement.

These remarks shew that the idea, generally prevailing, that land fitted for tea cultivation is limited, is erroneous; and were all the lands in Kumaon, Gurwal, Kooloo, Kangra, &c., so employed, teas could be prepared in sufficient quantity to supply both the Indian and European markets. The great reduction in the duty on teas, which must shortly take place in Britain, will lead to a treble consumption; and instead of 60,000,000 lb., we may shortly expect 180,000,000 lb. to be consumed in our markets. The impetus, too, given to trade, generally, by the discovery of gold in quantity, in two hemispheres, will affect no staple article more than tea, and lead greatly to its increased consumption. An inexhaustible market, when that of India is supplied, is therefore presented.

But it is a question :—Is India capable of growing teas at as cheap a rate or cheaper than China? In reply, I, from the small data which the returns of the Government plantations give, would say undoubtedly so. One of the plantations is now yielding 235 lb. of tea per acre, which, if sold at 6d. per pound, would yield £5, 17s. 6d.; and this, too, returned by land, the annual rent of which, received by the Government, is only 1s. 6d. per acre. For land generally in India, 58 rupees is a very high average return. Moreover too, teas sold at 4 anas, or 6d. per pound, would bring them within the reach of the poorer classes, and cause them to become as essential to the native hut as tobacco, which dates its introduction into India little more than two centuries. But in urging the importance of tea cultivation in the British Indian provinces, there is another point of vast importance to be considered, viz., that in Kumaon and Gurwal, whose area is equal to nearly 12,000 square miles, there is not a crop considered remunerative, where the district is distant from a good market, even though the land is only paying on the average about 7 anas or 10½d. per acre.* Why is this? Because intercommunication throughout the provinces is so bad. All trade must, owing to the state of the roads, be conducted by men acting as beasts of burden. The finer kinds of grain never realize more than a rupee (two shillings) per bushel, and this too, in order to be obtained, is frequently carried by parties ten and twelve marches, when their labour is always, when they can get employment, worth to them 2 anas or 3d. per day. This fully proves that, at present, in the Eastern British Hill Provinces, there is not in the back districts a remunerative crop in cultivation. Were tea cultivation generally introduced, such would not be the case; and as in China so in the Kohistan of North-Western India, it might, with much advantage, be introduced into every village, and the natives encouraged to sell their tea leaves to the manufacturer. For many years good teas will realize in this country 10 anas, or 1s. 3d., per pound*; and as a maund of raw leaves yields about 23 lb. of tea, the manufacturer might easily pay the cultivator eight rupees per maund on raw leaves, delivered at the factory, and at this rate reserve a broad margin of profit to himself. With such an inducement, natives would, I think, willingly undertake tea cultivation; as with good management they might realize from 80 rupees to 90 rupees per acre; and paid thus liberally, cultivators, even in the most distant regions, might deliver their leaves at the factories with considerable profit to themselves, though manual labour be employed in their transmission. But as the tea plant does not yield a return until the third year, and as, in the interval, the capital of the cultivators is thus locked up, it would, in order to induce them to enter readily on the cultivation with the assurance of security to their property so invested, be necessary to guarantee to them that all good leaves would be purchased at the above rate at the factories for a period of time; and this guarantee might, in the Kohistan of the Punjaub, with safety, be given for at least eight or ten years, either by Government, or by any party working the factories. In addition, all waste and unappropriated lands, when cultivated with tea, might be given free of rent for three years, and to the extent of from 20 to 30 acres to each individual desirous of doing so; and seeds and plants to cover them issued gratis. As a further inducement rewards, as in the opium factories, might be given to the first parties delivering leaves in the greatest quantity, and in the best condition, and on the following scale:—

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* The Government revenue rate is 12 anas or 1s. 6d. per acre, but only the land under cultivation, when the settlement was made, at present pays rent. If, therefore, the lands now broken up and cultivated are included, the average rent will not exceed 10½d. per acre.

1*st.* To the first party who delivers 100 maunds of raw leaves in good condition, 500 rupees.

2*d.* To the first party who delivers 50 maunds, 250 rupees.

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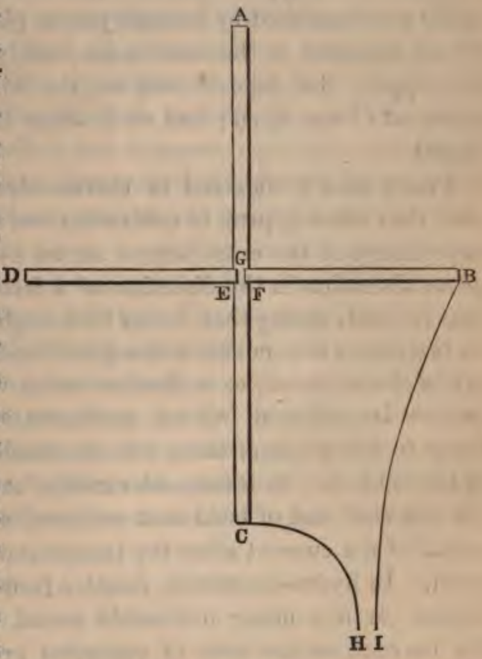
* At the last sales in Kumaon and Deyrah, the finer kinds of teas realized from 6s. 10d. to 9s. 10d. per pound, but these are fancy prices, and cannot be maintained when the teas are produced in quantity. In England the finer kinds of Kumaon teas were pronounced by the London brokers to be worth from 2s. 6d. to 3s. 6d. per pound. The average given by me, viz., 1s. 3d., is, therefore, a low one.

3*d*. To the first party who delivers 25 maunds, 100 rupees.

To conduct the operations under my orders at the Holta plantation, which, up to the 31st December 1852, were carried on by an active and intelligent native, a first class pupil of Delhi College, Hurdeo Sahae, I have, with the permission of the Honourable the Lieutenant-Governor, transferred Mr Rogers, overseer at Bheemtal, in Kumaon, who has for several years superintended the tea plantation in that district, and is, therefore, well acquainted with his work. I trust that this arrangement will meet with the sanction of the Most Noble the Governor-General.

On the Generation of Electrical Currents. By RICHARD ADIE, Esq., Liverpool. Communicated by the Author.

My object is to give an experiment, which goes to shew that a body may be electrified negatively or positively under certain conditions that are determined by a change in the conducting circuit, so that a terminal wire shall exhibit either kind of electricity at pleasure, without any alteration in the generation of the current. This fact being established, it will serve to explain cases of the reversal of a current, where there is no apparent change in the chemical or molecular action which has produced the electricity. The experiment is founded on one I published in vol. xxxvii., p. 301, of this Journal. A figure of the cross for testing M. Peltier's law is there given, to illustrate some experiments to disprove the assertion that a current of electricity could, in passing across a joint, cool it. Since that time I have given experiments to shew that when a joint appears to be cooled by an electrical current, the reduction of temperature can be traced to the cells of the battery where the electricity is being generated; and that the current which appears in the outer arms of the cross is not generated at the central joint, but is merely an off-shoot, drawn by the resistance of the joint from the main current. This was suspected when the cross experiment was first proposed; and they devised a method for testing the question, which, however, failed to prove what was sought. Since then I have found that, by regulating the section of the joint the galvanic current has to cross, it can be readily shewn that the current in the outer arms increases and diminishes, and this with arms of the same metal, where heat gives very little thermo-electrical action. Let a cross be made of two strips of rolled zinc, cut off the same sheet of metal, when the section of the central joint is quite small; a large portion of the current appears in the outer arms of the cross; but as the section of the joint is enlarged, the quantity of electricity which appears in the outer arms decreases, until with a large section it disappears altogether.



The annexed diagram represents a cross, composed of three bars of bismuth; AC, a long bar; and DE and FB two half bars. The ends E and F of the half bars were placed in metallic contact with the bar AC, but with a space intervening between them at G, whereby a galvanic current, passing along DB, had two joints to cross, one at E and another at F. When the space at G was closed, by pressing the points of the bars together into metallic contact, then a galvanic current passing along DB had only one joint to cross. The extremities of the bars at A and D were connected by wires with a Smee's battery of one or more number of plates; and the other extremities at B and C had wires BI and CH soldered to them.

The wires at H and I were connected with a galvanometer.

The battery current was sent in the direction AED, when the needles of the galvanometer shewed a current in the outer arms, moving in the direction CEB. The two short bars were then brought into contact at G, and the current through AED established. The galvanometer now shewed a current moving opposite to the one first obtained, being in the direction BEC. The sole cause of this change was the alteration in the joints at G, where the resistance to conduction turned off from the main current, passing along AED a portion of the electricity into the outer arms. These two experiments were repeated with the wires H and I immersed in a sulphate of copper solution; the battery current through AED was furnished by a single pair of plates; the electricity which appeared in the outer arms readily precipitated metallic copper; the deposit was on the wire at H, when the space at G was open; and on I, when the space at G was closed.

I have seen it objected to thermo-electrical experiments, that they often appear to contradict one another. With this experiment of the cross before us, we need not be surprised at an alteration in the direction of a feeble galvanic or thermal current, seeing that it may be brought about by a change in resistance to conduction in a joint the current has to cross, while the chemical, or molecular action which generates the current is unaltered. Cases, in illustration of this view, will occur to the minds of those who are familiar with the details of the subject. In thermo-electricity, couples formed of silver and zinc, and of hard-cast antimony and iron, shew a reversal of the current after the temperature passes a certain point. In hydro-electricity, couples formed of two pieces of copper, or any other oxidizable metal, give a reversal of the current, as the rate of oxidation predominates on the one or the other slip—instances which give us evidence of parallelism between the thermo and hydro electrical couple.

In observing the action of the water battery, I gave a series of experiments in vol. xxxviii., p. 99, of this Journal. A continuation of these led me to the unexpected result, that the active oxidation of a piece of metal converted it into a negative element, which has since been confirmed by M. Viard in an elaborate memoir (see *London Philosophical Magazine*, No. 39).

The negative condition of a rapidly oxidizing plate is in some manner connected with the nascent state of the oxide, and the metal to which it owes its birth; it is here that the joint, the galvanic current has to cross occurs. The apparent contradiction of an oxidized plate being negative, may be explained, by supposing a class of chemical action where the metallic surface in the act of producing an oxide acts as a powerful negative, or it is an arrangement like the experiment in the diagram, with the space at G open.

An instance of the generation of electricity, for a useful purpose may amuse some of your readers. I give it on the authority of a credible eye-witness, who saw the process. A lady in New York undertook to light the gas by an electric spark; she shuffled her slippers over the carpet for a few seconds, and then approached the jet of the gas-pipe; the gas was turned on, and the finger held near the nozzel of the burner, to allow an electric spark to pass from it, which generally ignited the gas. The success of the experiment was of course influenced by the dryness of the atmosphere; but on the North American continent, a state of the air fit for such a purpose, is, it would seem, by no means uncommon. In this country a similar experiment for lighting gas by an electric spark from the finger is often enough performed, but our climate requires the aid of an electrical machine and an insulated stool.

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nopsis of the *Fall of Rain, &c., in the English Lake and Mountain District, in the Year* 1853. By JOHN FLETCHER MILLER, Esq., Ph. D., F.R.S., F.R.A.S., Assoc. Inst. C.E., &c. Communicated by the Author.

Number of Gauge.		STATION.		1853.		Average of Ten Years, 1844–1853.	Average Number of Wet Days.
				Rain in inches.	Wet Days.		
No.	I.	High Street, 90 feet above the Sea,	Whitehaven,	37·40	194	43·53	195
,,	III.	St James's Church Steeple, 79 feet above the street		25·18	,,	31·39	,,
,,	IV.	The Flosh, three miles south of Whitehaven,		41·38	202	50·07	195
,,	VII.	Keswick,		50·44	172	59·63	204
,,	IX.	Loweswater Lake,		59·61	189	67·29	198
,,	X.	Crummock Lake,		72·09	183	84·12	199
,,	XI.	Gatesgarth,		99·10	,,	114·75	,,
,,	XII.	Eskdale Head,		63·07	,,	77·87—7 yrs.	,,
,,	XIV.	Wastdale Head,		83·39	203	101·40	227
,,	,,	Kendal,	Westmoreland,	39·45	150	50·73	176
,,	,,	Selside, 6 miles north of Kendal,		57·98	125	73·55—5 yrs.	,,
,,	XV.	The How, Troutbeck,		65·97	173	79·29	189
,,	,,	Ambleside,		66·27	149	79·59—6 yrs.	174
,,	XVIII.	Seathwaite, at 10 inches above the ground,	Borrowdale,	113·69	217	140·55*	215
,,	XIX.	Do., at 22 inches ,,		111·61	,,	133·99—6 yrs.	,,
,,	XX.	Stonethwaite,		95·65	191	111·45—7 yrs.	201

* Average at 10 inches (for 6 years), 137·60 inches.

The Mountain Gauges.

Number of Gauge.		STATION.	1853.	Summer Months, May to October.	Winter Months, November to April.	EXCESS PER CENT. above Valley.	
						Summer Months.	Winter Months.
No.	XXI.	Sea Fell Pike, . . 3166 feet above the Sea	56·17	38·72	17·45	−15·3	−53·7
„	XXI^2.	Lingmell, . . 1778 feet „	71·06	42·76	28·30	− 6·5	−24·9
„	XXII.	Great Gabell, . . 2925 feet „	59·72	41·73	17·99	− 8·8	−52·2
„	XXIII.	Sprinkling Tarn, . 1900 feet „	94·59	59·57	35·02	+30·3	− 7·0
„	XXIV.	Stye Head, . . 1443 feet „	92·65	56·77	35·88	+24·	− 4·7
„	XXV.	Brant Rigg, . . 924 feet „	73·40	41·69	31·71	− 8·9	−15·8
„	XIV.	Valley to the west, Wastdale, . . .	83·39	45·73	37·66	„	„
„	XIII.	Valley to the south-east, Eskdale, . . .	63·07	33·62	29·45	„	„
„	XXVI.	Seatoller Common, . 1338 feet above the Sea	111·45	57·80	53·65	− 1·7	− 2·3
„	XXVII.	The Stye, or Sprinkling Fell, 948 feet „	124·91	67·14	57·77	+14·2	+ 5·2
„	XIX.	The Valley, Seathwaite, Borrowdale, . .	113·69	58·77	54·92	„	„

Remarks.

Among several abnormal and opposite atmospheric conditions presented by the years 1852 and 1853, the departure from the average in the rain fall is the most obvious and remarkable. While the former was the wettest, the latter was the driest year since the experiments were begun in 1844. In 1852, the depth of water precipitated by the atmosphere at Seathwaite was equivalent to 156·74 inches, and, in 1853, to 113·69 inches,—a difference of 43 inches, corresponding to the average annual fall at Whitehaven in the last 10 years. Notwithstanding the great deficit in the quantity of rain, the wet days at Seathwaite are two *more* than the average number, and at Whitehaven they amount to four, and at the Flosh to eight *more* than the number in the preceding memorably wet year. In both years, the springs were unusually dry, and the fall of rain in the first six months below an average quantity. The depth of rain measured at Seathwaite, in December, was 1¼ inch,—in the last month of 1852, the fall amounted to 32·83 inches, and at Stonethwaite to 33·03 inches!!

Deductions relative to the Humidity of the Atmosphere at the Mountain Stations, in the Year 1853.*

STATION.		Dry Bulb.	Wet Bulb.	Deduced Dew Point.	WEIGHT OF VAPOUR.		Degree of Humidity (complete saturation 1000).	
					In a Cubic Foot of Air.	Required for Saturation of a Cubic Foot of Air.	1853.	1852.
Wastdale Head, (10h. 2m. A.M.),	247 feet above the Sea	46°·5	43°·0	38°·3	2·96 grs.	0·86 grs.	0·775	0·818
Do. (5h. 34m. P.M.),	. . .	48·8	44·3	39·6	2·98	1·14	·724	·788
Brant Rigg, . . .	924 feet above the Sea	45·4	42·0	37·3	2·87	0·81	·779	·828
Stye Head, . . .	1448 „	43·0	40·0	35·5	2·71	0·70	·795	·873
Lingmell, . . .	1778 „	41·2	39·1	35·8	2·74	0·47	·854	·896
Sprinkling Tarn, . .	1900 „	39·9	37·8	34·2	2·61	0·47	·849	·894
Great Gabell, . .	2925 „	36·8	35·2	32·6	2·42	0·36	·872	·945
Sca Fell Pike, . .	3166 „	34·1	32·9	31·1	2·28	0·25	·898	·933

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* These results are deduced from MONTHLY observations of the Dry and Wet Bulb Thermometers, corrected for slight instrumental errors.

HYGROMETRICAL OBSERVATIONS AT THE MOUNTAIN STATIONS.—The results are in strict accordance with those deduced from the observations taken in the previous year, and shew *that whilst the absolute quantity of vapour in the atmosphere gradually diminishes, the degree of humidity (or the dampness of the air relative to its temperature) proportionately increases in ascending above the comparatively level surface of the earth.* The only exception to the law occurs on Lingmell, where the humidity indicated in both years is slightly greater than at Sparkling Tarn, about 120 feet above it, although the additional quantity of vapour requisite to produce complete saturation is the same at both places. The stations are situated at opposite extremities of the valley, and the difference is no doubt attributable to local causes.

The experiments enable us to determine approximately the rate of cooling of the atmosphere by expansion, in ascending on the earth's surface above its general level. This may be computed by two independent classes of observations, or by combining the results of each—either by the observed difference in temperature between the valley and Sca Fell and Gabel—or by the monthly minima recorded by self-registering thermometers at Seathwaite and the mountain stations.

In 1852, the observed mean difference between the vale of Wastdale and the summit of the Pike was 12°·7, and in 1853, 13°·5;—the mean is 13°·1 in 2919 feet, shewing a fall of 1° in every 222·8 feet of elevation. In the same years, the depression between the valley and the top of the Gabel was 11°·6 and 12°·0 respectively in 2678 feet; or a mean rate of cooling by diminished pressure equivalent to 1° in 226·9 feet, during the day. The difference between the absolute monthly minima at Seathwaite and on the Pike was, in 1852, 13°·8, and in 1853, 12°·7 in 2798 feet—the mean result indicating a fall of 1° in every 212 feet, at night. A similar comparison with the Gabel gives a depression of 1° in 218·5 feet. The mean result of the day and night observations combined is equal to a fall of 1° in 220 feet of elevation.

The depression in the Dew Point between the valley and Sca Fell Pike was, in 1852, 9°·4, and in 1853, 7°·8, the combination shewing a fall of 1° in 339·4 feet in a perfectly saturated atmosphere. On the Gabel, the descent in those years was 7°·3 and 7°·0 respectively, shewing a mean variation in the vapour point of 1° in every 377 feet. The average result is a descent in the dew point of 1° in 358·1 feet in height, with a simultaneous fall of 1° in 224·8 feet in the temperature of the mechanically combined and invisible gases and vapour constituting the atmosphere.

The decrease of temperature in ascending appears to be more sudden during the night than the day; and as the mountain thermometers were thickly covered with snow in January, February, March, and December, the minimum temperature recorded in those months, and also the annual mean must be considerably higher than would have been indicated had the instruments been freely exposed to the air. It is therefore concluded that the rate of cooling upwards by expansion is in reality more rapid than is shewn by the result eliminated from the mean of the day and night observations, or 1° in every 220 feet of ascent. The variation indicated by the night observations alone (1° in 215 feet) is probably nearer the truth.

The conditions of the decrease of temperature in ascending *on* the earth's surface and *from* the earth's surface seem to be very different. From the observations made during four balloon ascents at Kew in the autumn of 1852, the number of feet of height corresponding to a fall of 1° Fahrenheit, was as under:—

On August 17, . .	292·0 feet.	On October 21, . .	291·4 feet.
„ 26, . .	290·7 „	On November 10, . .	312·0 „

All the ascents, however, shew an increasing degree of humidity up to the altitudes of the highest English Mountains.

OBSERVATORY, WHITEHAVEN, *February* 24, 1854.

On a Change of Ocean Temperature that would attend a Change in the level of the African and South American Continents. By JAMES D. DANA.

The idea of a change of climate consequent upon a change in the distribution of land and water on the globe, brought forward by Sir Charles Lyell, has recently been discussed with much ability and precision, by Prof. Hopkins, especially with reference to the Northern Atlantic. As there is profit in this consideration of possibilities, whether we can prove the actual occurrence of the supposed events or not, we briefly remark in this place upon another geological change that would affect the temperatures of both the Pacific and Atlantic Oceans.

Upon the oceanic isothermal chart issued with the last number of this Journal, and discussed in that and this number, it is observed that the whole western coast of South America is bordered by cold waters; and that while in the Pacific, 80° F. is the coldest temperature of the year in mid-ocean, towards South America, even under the equator, the ocean temperature of 74° is not found, in the cold season, short of a distance of 2500 miles from the coast.

We have also remarked upon the evidence that a similar southern or extratropical current affects the temperature of the whole southern Atlantic, and makes this literally the cold ocean of the globe.

It is moreover evident from the temperature of the waters off western South America, that the extratropical or antarctic current has a vastly wider influence here than in the southern Atlantic; the positions of the lines of 68° and 74° in the two regions make this sufficiently apparent. It is also obvious, that the South American Continent, by extending so far south,—22 degrees, or 1300 miles, beyond the south point of Africa,—should necessarily intercept to a large extent the antarctic current, and thus occasion, in connection with other causes, the northern flow that influences so widely the temperature of the waters off this coast. The position of the isocryme of 35°, shews that this same current flows on, rising somewhat northward towards Cape of Good Hope; yet the

African continent lies so far to the north, that it can in fact intercept but a small part of the southern current, which consequently to a large extent passes on south of the Cape; yet this small part produces the wonderful effects pointed out.*

Suppose now, that by a change of level, America were to terminate in latitude 34° S., and Africa in latitude 56° S.: the relation of the two, and of the cold influences of the currents adjoining, would be entirely changed. The vast area in the South Pacific, embraced between the west South American coast and the isocryme of 74°,—which marks the influence in the colder season of the cold southern waters, though not by any means its extreme limit,—would, if transferred to the Atlantic equatorial regions, stretch nearly or quite across from Guinea to the East Cape of South America; and the line of 68° would sweep around north of the equator quite to mid-ocean. The actual extent of the change may be perceived with close accuracy if we transfer the isocrymal lines off this part of Western America to the Atlantic. In the Pacific, under the same circumstances, the line of 68° would nowhere reach within several degrees of the equator.

The distribution of marine life would be greatly changed. While now the west coast of South America is, as regards the ocean, one of the coldest regions for the latitude in the world, it would become very much moderated, and a considerable portion of coast would be bordered by tropical waters. Along by Lima, and far south, there might be coral reefs. In the Atlantic, on the contrary, the Gulf of Guinea now characterized by torrid waters, would be filled with the colder seas of the temperate zone, and true tropical life would be altogether excluded.

The influence also on the Gulf Stream would be very decided, and the whole North Atlantic would feel the change.

It is a remarkable fact, that while the west coast of America is bordered in the tropical part by cold waters, 10°

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* We find that at the recent meeting of the British Association, Mr A. G. Findlay, in the course of a paper on the oceanic currents of the Atlantic and Pacific, takes the common view that the Lagulhas current is the origin of the current that flows up the West African coast, a view shewn to be untenable.

to 12° below the mean of mid ocean, and the marine zoology is hence extratropical, the temperature of the land is peculiarly torrid over the same latitudes. It is evident that in judging of the influence of the ocean temperature on the temperature of the land, the direction of the aerial currents for the year, should be considered as a most important element towards any just conclusions.

Although we cannot shew that the supposed change of level in the continents has taken place, we may learn from the facts what vast changes in marine life have happened in past ages, through such changes of level as have occurred in the earth's history. The changes on the land from this cause would be less marked; besides, these have had far less influence on the life of the rocks than those of the ocean, as the fossiliferous rocks are mainly of marine origin. We know that in the cretaceous and tertiary periods, the Andes were in part under water, or at a much lower level, and effects of the kind considered cannot be altogether hypothetical.—(*American Journal of Science and Arts*, vol. xvi., p. 391.)

On the Influence of Undulating or Hilly Ground in checking Currents of Wind. By RICHARD ADIE, Esq., Liverpool. Communicated by the Author.

> " So, pent by hills, the wild winds roar aloud,
> In the deep bosom of some gloomy wood."

My attention was directed to this subject by observations which I made on the growth of trees in the country around the borders of the Irish Sea in the neighbourhood of Liverpool. I there remarked, that where the sea-board is backed by the hills of Wales, trees grow with vigour at a comparatively short distance from the coast, while on the Lancashire shore, to the north of this town, where there is an extensive flat very little elevated above the surface of the adjacent sea, the trees have a stunted, poor appearance. I believe the cause of this can be shewn to be due to the hilly ground checking sea winds, which are sometimes loaded with a principle most deleterious to vegetation. To shew how this property of a sea breeze gets into the atmosphere, I had better first describe the formation of "spoon-drift," a technical term applied by sailors to water raised into the air from the sea in a manner which gives it properties widely different from any other form of atmospheric moisture. Spoon-drift is formed by a stormy wind striking the tops of agitated waves, and taking from them particles of sea water.

In the Mersey, during gales, I have on several occasions witnessed the spoon-drift and some of its effects. I have stood on the Cheshire shore and looked towards Liverpool, and noticed along the dock-wall a belt of cloud which was raised by a strong west wind striking the agitated tops of the waves formed in that locality at the time. This belt of cloud was in rapid motion, being carried forward by the force of the wind. In the town, the day after the storm, the windows of the houses had a soiled appearance, occasioned by the salt which had dried on them. In the country, on hedge-rows, I saw, pendant from the twigs, drops of water which tasted strongly of salt. Storms of this kind rarely occur during the season of verdant foliage, but when they do happen in that period, their effect on vegetation is most marked. On the 2d October 1853, the Mersey was visited by a violent gale, which raised spoon-drift, and distributed it in the manner I have stated. In forty-eight hours after the storm the leaves of the trees, on the windward or exposed side, had a shrivelled, scorched aspect. A road near Birkenhead, lined with two thriving, hawthorn hedges, presented the singular appearance of two different colours, occasioned by the one side being a windward surface, the other side a leeward one. The leeward surface escaped the saline spray, and retained the dark-green colour natural to it at the end of summer;—the windward surface was changed to be quite brown, through the deadly action of salt on vegetation. The hard spine-like leaves of the gorse bushes and the evergreen pines are often, during the winter months, browned on the parts exposed to a saline atmosphere; but, so far as I have been able to note, winters which do this to any extent do not occur oftener than once in three to five years. In the spring, after a season that has had a saline gale, I have heard it remarked by a traveller who had gone over the extreme range of British railway-ground, that Lancashire appeared more blighted than the moors, or any other place he had passed over; it is due to the lands of this county being exposed to be swept by strong westerly gales from the Irish Sea, carrying with them particles of sea-water. Arboreal vegetation, from its elevation, is more liable to be injured by sea salt than the cereals, or other plants which form the object of the farmer's care. The latter, for a long period of their growth, only rise a few inches above the surface of the soil, while, during the time of their most active development for flowering and seeding, saline storms are rare; hence it is that ground where trees thrive badly is found covered with fertile corn-fields.

The influence of hills in checking winds within a certain sphere of their action, is shewn in the quotation given above from the Iliad, translated by Pope; for if wind rushes with much violence down a gap among hills, the fact of its doing so, which is so well known, and is here established on the authority of one of the oldest of authors, shews that there must have been resistance offered to it by the form of the ground. On the Cheshire side of the Mersey there was an inlet called Wallasley Pool, where the tide ebbed and flowed through a hollow very slightly depressed below the neighbouring country; the upper part of the pool passed through a flat marsh only elevated a few feet above the highest tides. On the southern border of this marsh there is a hill 200 feet high; but, with this exception, the ground around the pool is low; yet the winds issuing from the gap were often a cause of anxiety to the boatmen of the Mersey; and I have been told of serious boat accidents off the mouth of Wallasley Pool. This character is likely to be altered now, for the tide has ceased to ebb there. It has been converted into a great shipfloat, filled with water, and studded over with the masts of shipping; but when the surface was open, the influence on the atmosphere of a slight depression was often observable.

The action of trees and ridges of ground in retarding the motion of the air is very different; wind in passing through trees is retarded by the friction of the air on the leaves and branches. When wind has to rise over a ridge of ground, there is the friction of the air on the earth's surface, and if all the air which ascended the ridge were to descend on the other side to the same level, so that the opposite surfaces of ridge resembled the two arms of a syphon, then the friction would be the only retarding force. But this is not what occurs in nature, which will be at once seen if we look at a mountain ridge on a great scale. Take for illustration the island of Great Britain; a large mass of air annually passes across its surface from the Atlantic to the German Ocean; in its transit a quantity of aqueous vapour is condensed, and descends in the form of rain. A part of the rain is derived from vapour which has been evaporated from the surface of the island, and is only a process of return—the state of the earth as to moisture, in an annual mean, being nearly stationary. The extent of the condensation of vapour which has come from the sea or foreign ground is measured by the annual discharge of our rivers. The vast volume of air annually condensed on the surface of the island may be conceived, when the quantity of water discharged into the sea is multiplied 1700 times; and the winds have suffered from the discharge of their aqueous vapour a retarding force measured by the gravitating of the rivers in their descent to the ocean, for the weight of water is lost to them on the descending limb of the syphon.

If we reflect on the extent of the water-power of this island, some idea may be formed of the vast body of air required to be condensed to produce it. Again, this formation of water-power brings another force into play which tends to give a horizontal motion to the air, namely the vacuity left by the condensed moisture. Consequently when we come to consider the effect of elevated ground on the atmosphere in its widest sense, experience shows that it acts as a disturber; the most palpable proof of this is afforded by the general quiescent state of the extensive flat surface of the Pacific Ocean,—the name pacific being an indication of its character—contrasted with the stormy portions of this ocean which lie around Cape Horn and the Cape of Good Hope.

The action of undulating ground in checking currents of air refers to localities within a certain range of their influence; in such situations trees are found in a more luxuriant state of growth near the sea, than would have been the case if the ground around them had been flat; at the same time the fact must not be lost sight of, that while hills protect much of the surface from winds, they also expose certain localities where the wild winds roar more than on any sea-girt plain.

A calculation of the weight of air which a ridge of very moderate elevation will raise hourly, may startle some of your readers. Take a ridge of 10 feet high on a sea-board of 100 miles in length. According to Mr Hartnup, in his meteorological results for the Liverpool observatory, 1852, the mean horizontal motion of the air for the year is 13 miles per hour. The mean weight of the air that crosses may be counted at 2 lb. per cubic yard, which is nearly 30½ grains to the 100 cubic inches. And suppose that the stratum of the mass in motion is 300 feet thick, the calculation founded on these data shews the weight of air raised 10 feet during every hour, to be 310 millions of tons. In the mean state of dryness, the atmosphere contains 14 parts per 1000 of aqueous vapour, which proportion gives for the water raised 10 feet along a sea-board of 100 miles, 4¼ millions of tons per hour—a large quantity of this vast weight being capable of condensation into rain.

The gales required to form the "spoon drift" which I have described as so destructive to vegetation, may be judged of from the subjoined notice, extracted from Mr Hartnup's report.

The following results shew the comparative violence of the four heaviest gales of wind which passed over the observatory during the year 1852:—

		Extreme pressure on the square foot.	Greatest velocity of the air between any one hour and the next hour following.
January	4.	28 pounds	53 miles.
...	9.	29 ...	62 ...
December	25.	42 ...	70 ...
...	27.	42 ...	71 ...

Address delivered at the Anniversary Meeting of the Geological Society of London on the 17*th February* 1854. By EDWARD FORBES, Esq., President of the Society.

[We regret much we have not space for the whole of this very valuable report of Professor Edward Forbes, but the few highly important facts we have selected will be read, we are sure, with great interest, as their novelty and importance calls for.]

That the greater part of my report will take cognizance of Geology under its palæontological aspects, is a circumstance not dependent on my own predilections or peculiar line of study; it so happens that the majority of important papers published during the past year have been more or less of this character, and some of the most valuable of recent contributions to our science concern principally the natural history department of Geology.

In the course of study of the many lately-published memoirs from which the materials of my Address are derived, the question of the meaning of the difference and contrast that are evident when we compare the faunas and floras of the more ancient or palæozoic with those of later epochs, has, in consequence of fresh accumulation of relevant facts, forced itself vividly upon my attention. It is a subject that, in common with most geologists, I have often earnestly thought over, and more than once published opinions upon. It has been the originator of not a few theories and speculations, not one of which can be said to have borne the test of searching inquiry into facts. Yet I think I am not wrong in saying, that a belief is as strongly impressed as ever on the minds of geologists who take interest in the philosophy of their science, that some law lies at the foundation of this difference. If I venture to add one speculation more, although its predecessors have either subsided into azoic oblivion, or linger retaining but a weak hold upon our minds, I do so in the hope that there is a vitality in my offspring, which may enable it, when it becomes developed, though as yet only a suggestion, to endure; and I ask your indulgence for introducing it on this occasion, on the plea that it owes its birth to reflections arising out of this discourse.

The publication of the first volume of M. Barrande's great work on the Silurian System of Bohemia is a leading event of the geological year just completed, and from its importance commands our first attention. The researches, the results of which are embodied in this elaborate and beautiful treatise, were commenced twenty years ago, but have been more especially prosecuted during the last thirteen years. From time to time we have had more or less detailed notices of the fruits of M. Barrande's assiduous labours, but could scarcely judge of their minuteness and importance until he commenced to send them forth in full. He now takes his place definitely in the foremost rank of geologists and palæontologists. He combines in a remarkable degree both qualifications,—no small advantage when the wide general views and the classification of great formations, such as are dealt with by this eminent man, have to be fully considered and put forth with ample arguments. Division of labour is good for the accumlation of sound and abundant materials, but experience has shewn in both geology and the other sciences, that the greatest advances are to be made by combinations of kinds of knowledge in those who deal with the greater problems. M. Barrande has done well, it seems to me, by pursuing assiduously the double course he has chosen. The main body of the purely geological portion of his work he proposes to publish when the palæontological details, which constitute most of the evidence upon which his views are founded, have been laid before the geological world in all their completeness. The task he has before him in this respect is a laborious one; no less than the detailed description and critical investigation of some 1200 species of fossils,—for such is the number that has rewarded his search in Bohemia. The natural history and principal part of his volume, a bulky work in itself, is devoted to the order of Trilobites. It is prefaced, however, by a general outline of the geology of Bohemia, which first deserves our notice, both on account of the interest it must present to British geologists dealing with palæozoic strata, and also because of certain original and peculiar views put forth in it.

The Silurian formation of the centre of Bohemia constitutes a well-defined basin of an elongated oval shape, the great axis of which is directed nearly N.E. and S.W., and has a length of about 20 German geographical miles, with a maximum breadth of 10. It is from 55 to 60 miles in circumference. Towards the N.E. and N. a small portion is bounded by the Trias, the Quader-sandstone, the Planer-kalk, or by the Carboniferous formation. Elsewhere, for two-thirds of its margin, granite or primordial crystalline rocks, such as gneiss and mica-slate, constitute its base and its boundary. A few small carboniferous basins are sprinkled over the Silurian surface, as well as a few isolated outliers of cretaceous beds. The dip in the two halves of the basin, the one to the N.E. and the other to the S.E. of the chief diameter, is towards the principal axis. The beds ordinarily lie at an angle of from 30° to 45°, often 70°, and are not unfrequently vertical.

M. Barrande distinguishes eight stages of strata to which he assigns a Silurian age; four of them he regards as Lower Silurian, and four as Upper Silurian. Of his Lower Silurian stages the two lowermost are azoic, the distinctions between them being founded on mineral characters, the first being composed of crystalline rocks, and the second of clay-slates and conglomerates, similar to the fossiliferous Silurian above them, but wholly void of organic remains. They are rich in lead mines. These azoic stages pass into each other, and the upper section passes gradually into the fossiliferous beds above.

The third stage of his Lower Silurian, and the first of his fossiliferous horizons, includes his "Schiste protozoique," and attains a thickness of 1200 feet. It contains no beds of limestone. The fauna of this section is very peculiar; it is composed almost totally of Trilobites, the other fossils being a Pteropod, some Cystideæ, and an Orthis. These constitute an assemblage upon which he lays great stress, and designates *primordial*. All its species, without exception, are peculiar to itself, and of the Trilobites, all the genera are so, with the exception of *Agnostus*. The peculiar genera are either low and rudimentary types, or members of the Olenoid or Calymenoid families; not typical or highly developed forms. They are *Paradoxides*, *Conocephalus*, *El-*

lipsocephalus, *Sao*, *Arionellus*, *Hydrocephalus*, and *Agnostus*. Of the first of these genera there are no fewer than twelve species, some of them exceedingly prolific. These primordial Trilobites have a peculiar facies of their own, dependent on the multiplication of their thoracic segments, and the diminution of their caudal shield or pygidium. M. Barrande compares this primordial fauna of Bohemia with certain fossiliferous assemblages similarly placed at the base of the fossiliferous Silurians in Wales, Norway, and Sweden, in which last country, indeed, the peculiarities of its fossils long ago attracted the attention of naturalists and the notice of Linnæus.

The isolation of this primordial zone, as distinguished from the mass of the Lower Silurian, is chiefly maintained by the grouping in it of the Olenoid family of Trilobites, almost to the exclusion of all others. It is not quite certain that more than one of the genera of Trilobites distinctive of this zone are found in any higher beds. The exception is *Agnostus*, the lowest and most rudimentary type of its tribe. Yet even this has its metropolis in the primordial zone, and sends but a few stragglers into the division immediately above. The same, or a very similar distribution, has been observed of late years by Angelin, who, during 1852, commenced illustrating the fauna of the Swedish rocks.

In Wales the existence of this primordial fauna has been clearly made out. The rocks which contain it are those designated by Professor Sedgwick, who recognised their importance, as the "Lingula beds," a name adopted by the Geological Survey. Fossils were first, I believe, found in them by Mr Davis, who discovered the *Lingula*, from which they received this name. They have been thoroughly examined by my colleagues of the Geological Survey, and are stated in the *resumé* on the Lower Palæozoics of N. Wales, communicated by Professor Ramsay to the Society last April, to be about 7000 feet thick. Their importance has been fully recognized for some time by the surveyors, and the additional evidence accumulated last autumn by M. Salter goes to support the stress laid upon them by M. Barrande. In the prosecution of the search, a further result has been obtained in the way of a subdivision of the group, and a palæontological distinction of importance has been indicated. They prove capable of division into two well-marked sections, viz., a lower, of which *Agnostus* (probably the identical species described from the alum slates of Sweden), an *Olenus*, and *Conocephalus* occur along with the characteristic *Lingulæ* of the deposit; and an upper, where the same genera are accompanied by a few Brachiopoda and Bryozoa, as in Bohemia. But whereas, in the latter country, no passage can be shewn of this fauna into the Silurian stage above, in Wales a palæontological passage from the Lingula beds into the Bala or Llandeilo group appears to be indicated. This is marked by the association in the upper part of the igneous series of two large species of *Olenus* with *Agnostus* and *Lingulæ*, and with types unquestionably characteristic of the Llandeilo beds, such as *Asaphus*, *Calymene*, and *Ogygia*, and Graptolites of species undistinguishable from those of the Llandeilo flags.

The fourth and uppermost division of M. Barrande's Lower Silurians is his "Etage D;" strata chiefly composed of quartzites with schistose alternations. Cephalopoda represented by *Orthoceras*, Pteropoda by *Conularia* and *Pugiunculus*, Heteropoda by *Bellerophon*, Gasteropoda by *Pleurotomaria* and *Holopea*, Acephala by *Avicula* and *Nucula*, Brachiopoda by *Orbicula*, *Lingula*, *Spirifer*, *Leptæna*, and *Terebratula;* also Crinoids, Cystideans, Starfishes, and a few Corals and Graptolites make up, with *Trilobites*, the fauna of this group in Bohemia. Trilobites and Cystideans prevail above all other forms, and it is in this zone that the former (and the latter probably also) attain their maximum.

Of the four stages of Upper Silurians in Bohemia, the three lower divisions are typically calcareous, and the culminant section schistose. The lowermost has a base consisting of traps alternating with black slates containing Graptolites, and including occasional concretionary limestone. It attains a thickness of not more than 900 feet, but has a fauna superlatively rich and prolific in fossil treasures. Between 500 and 600 species of organic remains have been collected in this formation. In it is found the maximum number of species of Trilobites, no fewer than 78; and several genera, including *Harpes, Bronteus* and *Proteus*, appear for the first time in Bohemia. Cephalopoda abound; as many as 200 species, of which half are Orthocerata, have rewarded the collector. *Ascoceras, Gomphoceras*, and *Phragmoceras* are the characteristic types. Gasteropods, Lamellibranchs, and Brachiopods are numerous, and there are not a few Zoophytes.

The second or middle stage of Upper Silurian limestones presents a decreasing fauna, but at the same time exhibits the maximum of Brachiopoda. Bryozoa and Tentaculites appear, and Cephalopoda rapidly diminish in numbers.

Between the third or upper stage of these limestones and the last there is a gradual passage, and in these fishes commence and Brachiopods have become rare. A considerable number of species in this division are enumerated as common to it and the two last.

In the uppermost stage of culminating schists the community of species is reduced to two Trilobites, and the entire fauna is poverty-stricken. Traces of vegetables indicate some considerable changes in the conditions of the sea bed.

For years, ever since 1828, palæontologists have dreamt of Trilobitic metamorphoses, and some have pronounced definitely for, some as definitely against, the probability of the Trilobite undergoing changes in the course of its existence as an individual. The full discovery and statement of the fact was reserved for Barrande in 1849. In the same year Mr Salter shewed that the young individuals of *Ogygia Portlockii* presented 4–7 segments, and finally 8. Milne-Edwards and Burmeister, naturalists thoroughly versed in the history of living Crustacea, had previously speculated freely from analogy on the probability of their transformations. M. Barrande, in the work before us, demonstrates a metamorphosis in no fewer than 16 genera and 28 species. The degree of change is variable; its intensity comparable with the phenomenon in existing Crustacea. The successive and progressive elaboration of all the elements in the pygidium before becoming free and passing into the thorax, holds good in all known metamorphosing Trilobites. The number of species in which a change has been proved diminishes as we ascend in time. Among other points, M. Barrande has made out the probable eggs of these animals. As to their mode of life, he opposes the conclusion of Burmeister and others, that Trilobites lived in shallow water along the coast; and distinctly pronounces against the supposition of their parasitic nature.

A great step has been made towards an explanation of some of the organic phenomena of the Oolites by Professor Morris, whose memoir "On some Sections in the Oolitic District of Lincolnshire," communicated to the Society in June last year, throws new and valuable light on the relations of the southern to the northern oolites in England, and rectifies several misconceptions about the comparative order of the strata in different districts. As this paper, one of the most important in its general bearings laid before us during the past year, is printed entire in our Journal, I shall make no abstract of its details, but merely offer a few remarks on its general bearings.

The marine faunas of the Oolitic epoch indicate at least three great and widely-spread assemblages of types, each exhibiting a general and easily recognizable facies. These aspects may be termed respectively the Liassic, the Bathonian, and the Oxfordian; the two latter terms being used for want of better, and being adopted in a wide and general sense, and not in the restricted meaning in which they are used by M. Alcide d'Orbigny. The horizon of change of facies at the boundary between each is a horizon, to a considerable extent, of change of species. I believe that every year's research will make it more and more evident that the perishing of species is simply the result of the influence of physical changes in specific areas, and depends upon no law of inherent limitation of power to exist in time. If so, we should expect to find indications of the cause of the greater changes in the oolitic and marine fauna in the shape of strata bearing evidence of a wide-spread change of physical conditions within the great oolitic area. An extensive change of species within a marine area, in all likelihood, is dependent on an extensive conversion of that area into a terrestial surface.

Now it is becoming more and more clear that such a change of condition occurred over a very wide area in the interval between the main mass of the middle and upper jurassic types. The researches of Mr Morris do much towards completing the demonstration of the nature and extent of these changes in the area now occupied by the British Islands, and it will be seen hereafter, how, even as far away as Italy, we have clear proofs of a similar change of conditions about the same epoch. Much may be done towards clearing up the details of this matter by more extensive and careful investigations of the Scottish oolites, guided by the light that is opening gradually upon us. Indeed I know of no field more likely to yield fresh laurels to the British geological observer than the thorough exploration of Scottish secondary geology.

In a paper by Professor Buckman, published in the "Annals of Natural History" for November last, and one of the many interesting contributions to British geology which we owe to that active assembly of provincial observers, the Cotteswold Naturalists' Club, the Cornbrash and associated strata of the neighbourhood of Cirencester are described in detail, and under an economical point of view not always attended to, viz. the agricultural value of the soils formed by the several oolitic rocks. Through the predominance of phosphoric acid and sulphate of lime in the Cornbrash, as compared with the "stone brashes" of the Great and Inferior Oolite, the value of the soils in the former rock is considerably greater, as shewn by the analyses of Professor Vœlcker.

The description of the fossil animals of the nummulitic rocks of India, by Vicomte d'Archiac and Jules Haime, elsewhere alluded to when the monograph of Nummulites was mentioned, will, when completed, form a manual of the highest value for the study of this extensive formation in the East. The part already published contains the account of the Corals and Echinoderms (as well as the Nummulites), and is preceded by a review of the geology of the nummulitic region of India. This chapter is not a mere summary of what had previously been known and published. It contains much that is new, facts of high value derived from the researches of our associates, Vicary, A. Fleming, Oldham, R.

Strachey, Thomson, and J. D. Hooker. Sir Roderick Murchison has been the means of placing these fresh data at the disposal of M. d'Archiac. The result of these studies has been the confirmation of the complete independence of the nummulitic in regard to the Cretaceous formations. "In the province of Cutch, in Scinde, Beloochistan, the Punjaub, and along the slopes of the Himalaya," remarks M. d'Archiac, "the beds beneath the nummulitic limestones exhibit nowhere the characters of any stage whatsoever of the chalk, whilst, wherever the substratum has been recognized, it exhibits those of carbonaceous deposits with clays and sandstones belonging to the lower tertiary formation, and resting either on Jurassic strata, or on more ancient rocks of which the age is yet unsettled."

Organic Remains. The enormous increase of palæontological observations may be measured by a comparison between the number of species recorded in the first edition of Professor Morris' Catalogue of British fossils, and the number mentioned in those portions of the new edition that have gone through the press, and will shortly be published.

The number of plants recorded in 1843 was 510; in 1853, 652 are cited. The increase is chiefly among Mesozoic and Tertiary types. A great deal has been done to elucidate the structure and affinities of fossil plants in the interval, especially by Dr Hooker, Mr Charles Bunbury, Prof. King, Mr Dawes, and Mr Binney, but not so much towards adding new names to our lists of species. In Fossil Botany, this course of proceeding is a sign of advance of knowledge. The most marked increase in number of recorded species is among the oolitic and Wealden beds. The late lamented Dr Mantell did much of late years towards increasing the latter list. Were all the known fragments of distinct vegetables found in our tertiaries monographed and named in the manner of those I shall have presently to mention, described and figured in the lately published memoirs by Austrian botanists, our list would be considerably increased. They certainly ought to be made the subject of a treatise, and might be advantageously taken up by the Palæontographical Society, which, as yet, has given us no separate memoir on British fossil plants.

The Amorphozoa come next. In 1843, 76 named forms were recorded. In 1853, the number is increased to 116. The increase is in a great measure due to the labours of Mr Toulmin Smith among the Ventriculidæ, which, notwithstanding the arguments of their investigator in advocacy of their Polyzoan, and consequently Molluscan origin, naturalists are generally of accord to keep in their old place beside the Sponges.

The Foraminifera, 82 of which are mentioned as named types in the list of 1843, have increased to 168, besides numerous indications of unpublished and, as yet, unnamed forms. The next ten years will probably triple the amount of named fossil species of these exquisite minims of creation. The additions are chiefly new identifications of British fossils, with species described by continental authors, especially by Alcide d'Orbigny and Reuss. The merit of determining these is, I believe, in great part due to our Assistant-secretary, Mr Rupert Jones, whose authority stands very high in all departments of microscopic palæozoology. Mr Jones himself is an addition to the list of British Palœontologists during the last ten years, and one we all welcome. The labours of Dr Williamson and Dr Carpenter have also done much towards clearing up our fossil Foraminifera; and the untiring exertions of Mr Harris, of Charing, though inconspicuous in print, have, I believe, been a chief source of fresh materials towards the history of our cretaceous species.

In the first edition, the Zoophyta are combined with the Bryozoa. When the latter are eliminated there remain 183 zoophytes, chiefly corals. This number has been prodigiously added to within the last ten years, no fewer than 438 species being enumerated in the new catalogue. The increase in this instance is due to an entirely new treatment of the subject. To Milne-Edwards and Jules Haime a large proportion of the additions are indebted for their place. Mr Lonsdale and Professor M'Coy have also contributed extensively.

The Bryozoa, a few years ago regarded as Zoophytes, but now known to be low forms of the subkingdom Mollusca, amounted to about 132 in the first edition. In the new catalogue, they constitute a roll of no fewer than 249 species. This extended list is due to many investigations, and the newly-recorded types come from formations of all ages. Attention seems to have been suddenly directed to these curious bodies both at home and abroad. The study of the British fossil species, vast as is the increase of the recorded numbers, can be regarded only as in its commencement. I trust that geologists who may direct their attention to these bodies hereafter, will bear in mind the complete and searching analysis of the existing species drawn up by Mr Busk for the British Musem, and guide themselves in describing the fossils by the example of that valuable treatise.

The Echinodermata, 266 in number in 1843, are now 479; the record of species is daily increasing, but I do not think likely eventually to extend beyond 500 British forms. Major Austin, Professor M'Coy, Dr Wright, and myself, have been the principal workers in this beautiful, and in a geological point of view, invaluable order. The additions of the entire family, including not a few genera and species, of Cystidea to the list (for the Sphæronites of the former catalogue is probably not a cystidean), a group as characteristic of the lower palæozoic formation, as the Graptolites or myriads of Trilobites are, is one of the most striking instances of the progress of palæontological research, and one due for several of its most curious facts to the exertions of Mr Fletcher, and Mr John Gray of Dudley.

The named Annelida were 79 in 1843, they are now 129. The most interesting additions are among palæozoic forms.

The Cirripedia, 21 in 1843, are now 42. The value of the increase in this instance is not to be estimated by the merely doubling of the number. They have been thoroughly sifted by a master-hand, analysed with incomparable care, and by a combination of unsurpassed labour, with judgment and knowledge of the highest kind, have been brought to a state which may be regarded as, at least for many years to come, the epoch of maximum, in their investigation. To Charles Darwin we are indebted for this service.

The Crustacea are now 291; in 1843 they were 159. This is an enormous advance, and curious, since in great part it has arisen from additions to the list of palæozoic species. It marks, moreover, not merely an advance of names, but one of knowledge, as may be judged from an inspection of the changes in the generic list. The Trilobites have undergone a complete revision, and the number of species of those singular animals is vastly increased, thanks more especially to the work done by Salter and by M'Coy. The Cytheridæ and Cyprididæ have become a feature in the catalogue, mainly in consequence of the researches of Rupert Jones. Professor M'Coy has largely added also to the list of these tribes, and to the catalogue of the higher crustacea from our mesozoic and lower tertiary strata.

The additions to the list of fossil insects more than double this portion of the catalogue. They are due to the Rev. P. Brodie, and are entirely derived from mesozoic strata, chiefly from the Purbecks and Lias. In this department there is a considerable amount of unpublished materials existing in collections.

The number of Brachiopoda has swollen from 459 to 668, an addition of more than 200 species! In the mean time they have been undergoing complete and thorough revision. Mr Davidson, whose appearance among us as a British palæontologist has taken place in the interval between the two editions, is foremost among the workers in this department, one greatly increased also by the labours of King, M'Coy, and Salter. Some very interesting contributions have come from Mr D. Sharpe, and Mr C. Moore of Ilminster. The important discovery of Liassic species of Leptæna and Thecidium in Britain is due to the last-named observer.

The catalogue included 318 Monomyarian Bivalves in 1843; in the new edition 577 are recorded. The additions in this instance come from numerous sources. Both in this and the following group we owe much to the labours of Mr Morris and Mr Lycett among the Oolites.

The appearance of the first part of the "Description of the Fossil remains of Mollusca found in the Chalk of England," by our valued treasurer, Mr Daniel Sharpe, will be hailed with pleasure by students of cretaceous beds all over Europe. The portion published embraces the Belemnites, the Nautili, and part of the Ammonites, and contains descriptions and figures of 24 species, of which two are wholly new, and six new to British lists The range of cretaceous strata from whence the specimens described have been procured, extends from the Upper Chalk of Norfolk and Gravesend, to the Chloritic marl of the Isle of Wight, and "Chalk with green grains" of Somersetshire. It is worthy of notice that of the Nautili described, several are recorded as having an extensive vertical distribution; thus *Nautilus lævigatus* ranges from the Upper Greensand to the Upper Chalk, whilst *Nautilus pseudo-elegans*, *N. radiatus*, *N. neocomiensis*, and *N. undulatus* occur in both the upper and lower divisions of the Cretaceous system; in other words, both above and below the Gault. Every fact of this kind well ascertained, is of no small interest at present, when there is an extreme and unwholesome tendency on the part of many palæontologists to insist *à priori* upon the distinctness of species coming from different stages, and to force their diagnoses accordingly.

The essay on the classification of the Brachiopoda, by Mr Davidson, contains the conclusions arrived at after many years of conscientious labour, mainly devoted to this interesting order of Mollusks, for whose illustration we owe so much to his pen and pencil. No other palæontologist has ever had so great an amount of perfect materials for his particular task at his command, and neither expense nor labour has been spared by our indefatigable associate to render his monograph as perfect as possible. If any of our brethren dissent from some of his specific decisions, they must all admit that they have been arrived at on no superficial grounds. The portion of Mr Davidson's work now sent forth is entirely systematic, and is devoted chiefly to an exposition of the characters and definition of the families and genera of Brachiopoda. He admits thirty-three genera assembled under ten principal families, with some intermediate and doubtful or provisional groups. As he has endeavoured to define his genera on the strictest natural characters, and appears to have succeeded in arriving at an arrangement, in the main sound and near to the truth, it becomes an inquiry of considerable interest to ascertain how far the ranges of these genera are continuous in time; in other words, whether the theory of unique generic time-areas be borne out among the Brachiopoda, now that we may be said to have attained so extensive a knowledge of their generic and specific types. This was doubtless the idea working in the mind of Von Buch, when, with indifferent materials, he attempted to fix the characters of the fossil Brachiopoda, and plainly has often influenced the numerous attempts at their classification made by subsequent palæontologists. I have no reason to suppose that an *à priori* hypothesis, connected with either time or space-distribution, influenced Mr Davidson in coming to his final arrangement, and therefore I have been the more curious to see how far that arrangement accorded with geological considerations.

In the first family, *Terebratulidæ*, the typical genus *Terebratula* (of which *Terebratulina* and *Waldheimia* are regarded as subgenera), the succession of types is continuous from the middle palæozoic or Devonian epoch to the present time; whilst the other genera are either Upper Mesozoic, Tertiary, and recent (as *Terebratella* and *Argiope*), exclusively Upper Mesozoic (as *Magas*), or exclusively recent (as *Bouchardia*, *Kraussia*, and *Morrisia*.)

Stringocephalus follows as the type of a provisional family, exclusively Devonian.

The *Thecididæ*, represented by *Thecidium* alone, range continuously from the Trias to the present time.

The *Spiriferidæ* concentrate towards the palæozoic pole. In this family Mr Davidson includes *Spirifer* (with *Spiriferina* and *Cyrtia* as sections), *Athyris*, *Spirigera*, *Uncites* and *Atrypa*.

Rhynchonella, with *Camerophoria* and *Pentamerus*, form a family under the name of *Rhynchonellidæ*. The absence of perforations in the shell is the rule in this group. The typical genus is one of the links between the palæozoic and present epoch, and has its maximum in the Mesozoic.

The *Strophomenidæ*, *Productidæ*, and *Calceolidæ* all concentrate in the Palæozoics; *Leptæna* only, in the first named family, extending into the lower Jurassic strata.

In the *Craniadæ*, represented by the single genus *Crania*, we have a type of Brachiopod almost equally present at all epochs. The nearly allied group of *Discinidæ*, though extending to the present, is generically concentrated in the Lower Palæozoics. The same remark may be made respecting the *Lingulidæ*.

Accepting the genera adopted by Mr Davidson as mutually equivalent groups, and regarding their distribution in time as determined by him for a vast amount of specific materials, enough to induce us to believe that future discoveries will not materially disturb any inferences drawn from the numbers as now presented to us, then we arrive at several striking conclusions concerning the entire sub-class. Regarding the Present and the Lower Palæozoic epochs as opposite poles of time, we find the generic types among the Brachiopoda concentrate as it were around or towards each, whilst they depauperate towards the equatorial region of the scheme, about which indeed no generic types originate. The loop-armed types are regnant, as it were, anteally, the spiral-armed types posteally; and the latter are in the main so dominant, that the Brachiopoda, as a great assemblage of types, has its major development towards the past, its minor towards the present, and its zero in the parting epoch between the palæozoic and after-ages.

One of the distinctive features of our science during the year just past, is the monograph of Nummulites by Vicomte d'Archiac, constituting a portion of the "Description des Animaux Fossiles du Groupe Nummulitique de l'Inde."

The high geological value to which the Nummulites and their order, the Rhizopoda, have speedily attained during the last fifteen years, contrasts curiously with the degradation they have as rapidly undergone during the same period in zoological position. Before 1835, they were generally regarded as Cephalopoda, and naturalists of repute were not wanting who went so far as to describe even the parts of the minute cephalopod that constructed the foraminiferous shell. That they were not Mollusca was scarcely suspected, though half a century before their lower nature had been, on slender grounds however, often maintained. The assumption of their elevated zoological position led to many an argument against support of the theory of the prevalence of a warm climate during the ante-tertiary epochs, from the fact of the abundance of chambered cephalopods in the ancient sea-beds of now cold or temperate latitudes. The abundance of minute chambered Cephalopoda in the North Atlantic at the present time, and their almost universal distribution, were confidently appealed to as conclusive against the inference. Their number in the later formations, when the genera of Ammonitoida and Nautiloida had become scarce or disappeared for ever, was interpreted only as a continuance of the same class under new and minuter forms. Analogy was mistaken for affinity: and substitution of one group for one totally and organically different although in the mere form of test not dissimilar, was mistaken for succession and representation within the sphere of one type. But the discovery of Dujardin led the way to an entirely new interpretation of the value of the Rhizopoda, and a new view of the part they play in time. Proving, from good evidence, to be among the lowest of animal forms, to be in fact Protozoa like *Amœba*, but differing from both Proteus and the animal element of the sponge by their investment with a hard and symmetrically arranged (generally in spiral symmetry) exo-skeleton, it is most interesting to note that their advent and maximum development have been, not during the apparent dawn of life, but amid the later epochs, and chiefly during those ages which many palæontologists regard as especially characterized by the highest forms of the animal kingdom. Indeed, so far as we know at present, the whole great group of *Protozoa*—the group that stands as it were at the very base, and constitutes the rudiments of the animal series—is as characteristic of the tertiary section of time as the Vertebrata themselves are. A comparable phenomenon is becoming rapidly manifest in the molluscan subkingdom, now vastly increased by the accession of the Polyzoa to its ranks. These curious, lowly-organized, zoophytoid mollusca, instead of being the first of their type to appear, were preceded by members of all the higher orders of it, and do not become of much chronological value until the testaceous forms of the highest class of Mollusks occur, few and far between, and lose their strength and their importance.

The exquisite symmetry and regularity of conformation of the shells of most recent and fossil Rhizopoda were the chief sources of the errors that prevailed so long about their nature and zoological position. The true explanation of their structure appears to me to be that given in detail by our fellow-member Dr Carpenter, to the effect that the entire mass, however symmetrical or regular, represents the products by successive gemmation originating from a single ovum. It matters little whether we regard each "joint" or cell of a Nummulite as representing an individual or a zooid, provided we regard it as an element of the same essential nature with each polype of a polypidom, each cell-animal of a polyzoon, or individual of a Botryllus. The value of the regularity of the whole is not invalidated, because that whole is a compound and not a unity, and our faith in the specific value of the fossil, and its consequent geological importance, may be as strongly based on the constancy of characters whose diagnosis is drawn from the features presented by a congeries of individuals as from those presented by a single being. I make this remark, because the only serious objection that I can take of the views of M. d'Archiac touching the nature of the Nummulite concerns this fundamental point. When he states as an argument against its compound nature, that, if each of the cells were the proper envelope of a particular individual, we ought to find a greater irregularity in their development in the same shell, and asks why, if this theory were true, should the heights of different coils of the same spiral present constant relations, and why the first and last cells should be less large than those of the median whorls,—we cannot accept the objections, for a crowd of comparable phenomena presented by the sertularian zoophytes, animals having considerable affinity with the Polyzoa, although of higher organization, come to our recollection. The variations of the Hydroida, their morphology and reproduction, bear too close a relation to the phenomena exhibited by the rhizopodous organism, to permit us to regard the Nummulite and its allies as simple bodies, or to dispute the theory of their gemmigerous constitution; in other words the regulation of their organization by the law of paramorphosis.

The stratigraphical distribution of the Nummulites is especially of interest to the geologist. As compared with the grand scale of epochs, their reign was short, but it was well-marked and compact, and offers but one more proof to the thousands now known towards the demonstration of the unity of time-areas of natural genera—facts that should make us strongly hesitate before admitting the value of apparent and daily-decreasing exceptions, and that should give us fresh hope of the future attainment of a knowledge of the grand laws regulating life in its relations to time, and fresh faith in the biological section of the foundations of geology. The Nummulites characterize a portion, not the whole, of the tertiary epoch. Though once, and not many years ago, Nummulites were regarded to be as probably indicative of the cretaceous date of a formation as of its tertiary place, it would now appear that, between the nummulitic tertiaries and true cretaceous strata, deposits intervene, whose fauna and flora are such that we must regard them as of tertiary age. A most interesting and important feature of these deposits, traceable in the north-west of Europe, the south of France, in Savoy, in Switzerland, along the southern slopes of the Alps, in Istria, and even in India, is, that in numerous localities they exhibit evidences of a terrestrial origin, marked by the presence of coal, often accompanied by lacustrine shells, and sometimes by fresh-water limestones. In facts of this kind we may get at the true explanation of the break between the cretaceous and tertiary faunas, without having recourse to prodigious cataclysms or paroxysmal elevations of mountain chains, which, if they did occur, as might have been the case, could have made far less impression on the distribution of animal and vegetable life, except in the immediate vicinity of the convulsion, than slow and almost imperceptible changes affecting gradually the disposition of the geography of a wide-spread area.

"The dial moves, and yet it is not seen," paradoxically writes an old poet. Time cannot progress without change, however slow may seem his course. The true measure of the extent and importance of a convulsion (as well as of the importance of unconformity), should be the amount of organic change that we can trace to a connexion with the paroxysm. And yet what system of paroxysmal elevations has stood the trying test, when questioned on this principle?

It is of the Middle Eocene epoch—that section of the lower tertiaries of which the calcaire-grossier of the Paris basin may be cited as a central type and key-stone—that the Nummulites are especially, and apparently exclusively, characteristic. The supposed carboniferous and oolitic Nummulites are of too doubtful a nature to be taken as exceptions. There is, it is true, a Nummulite (*N. intermedia*) found in the Miocene beds of Piedmont, and another (*N. garansensis*) in the Lower Miocenes of the Pyrenees. But I am not inclined to conclude with M. d'Archiac that these rare exceptions prove the existence of the last representatives of the genus after the Lower Tertiary fauna had disappeared, but rather to cite them in favour of the view that I have attempted to demonstrate, I trust successfully, when describing during the past year the Lower Tertiaries of the Hampshire Basin,—to the effect that the so-called Lower Miocenes are essentially Lower Tertiaries and a portion of the true Eocene series, and that the passage from them into the Middle Eocene is perfect and gradual, when we have for our examination an area presenting a full sequence of deposits.

Nevertheless, it is not the less true that the nummulitic horizon is distinctly and definitely marked, and, from the frontiers of China and Thibet, even to the shores of the Atlantic, occupies a fixed position in the geological scale, a place above and succeeding the horizon of the lower tertiary lignites. The full demonstration of this great fact is a precious gain to our science; and when we consider what a vast area the nummulitic rocks occupy, what mighty mountains are made up of them, the prodigious accumulation of individuals of the fossils from which they receive their appellation, and the readiness with which their age can thereby be determined, we cannot but admit that the elucidation of their history has been a boon of no small value to comparative geology. This great tertiary formation extends across Europe, Asia, and Africa, forming a zone of 98° of longitude, comprised from south to north between the 16th and 55th degrees of latitude, and through much of its course exhibiting a breadth of 1800 miles. In the Himalaya, nummulitic rocks attain an elevation of more than 14,000 feet.

It will ever be a matter of just pride to our Society, that within our meeting-room and in our proceedings the main task was effected of clearing up the mist that clouded so long the geological history of the great nummulitic formation, and that here it is our indefatigable colleague, Sir Roderick Murchison, effected this great advance in tertiary geology. And now that the palæontology of the Nummulites has been made as clear as noon-day by the genius and labour of M. d'Archiac, it will ever be a matter of congratulation to us that the cabinets of our Society and the collections of its Members were freely and heartily placed at his disposal, and have proved of some value towards enabling him to perfect his researches.

The information now given, as far as I am aware, is new to geological language, and involves an idea which, although hypothetical, I wish to put forth upon this occasion. I am strongly impressed with the belief, that, fanciful though it may seem, there is within it the germ of a great geological truth. I have spoken of genera concentrating towards the palæozoic pole, and *vice versa*, of the substitution of groups, and the opposition of the more ancient to the mesozoic and modern faunas. The phrases have been incidental, and arose naturally out of the subjects under commentary, but the idea that lies at the base of them, whether true or fallacious, requires to be stated, and there cannot be a better opportunity than the present for venturing to start this fresh geological hare.

Every geologist whose studies have been equally or nearly equally directed to the organic phenomena of the three great sections of time usually received, Palæozoic, Mesozoic, and Tertiary or Cainozoic, cannot fail to have been struck with the greater value of the difference between the first or oldest section and the two newer divisions taken together, than between the first and middle terms and between the latter and the last. The degree of organic difference between the upper mesozoic and the lower tertiary epochs is rather more, but only slightly more, than the degree of difference between the lower and upper sections of the great mesozoic period. But the gap between palæozoic and mesozoic, although the link be not altogether broken, is vastly greater than any other of the many gaps in the known series of formations. I am one of those who hold, *a priori*, that all gaps are local, and that there is a probability at some future time of our discovering gradually somewhere on the earth's crust evidences of the missing links. All our experience and knowledge, theoretical and practical, warrant the affirmation that at every known stage of geological time there were sea and land. Even those who believe in a primeval azoic period will hardly sanction the supposition that there has been any repetition of azoic epochs since the first life-bearing era commenced. And if so, and if there were always sea and land since the commencement of the first fossiliferous formation, we are warranted in assuming that both earth and water had their floras and their faunas. All geological experience goes to shew that wherever you have a perfect sequence of formations accumulating in the same medium, air or water as the case may be, there is, if not a continuance of the same specific types, a graduated succession and interlacement of types and of the facies of life-assemblages: even as on the present surface of the earth the faunas and floras of proximate provinces intermingle more or less specifically, or, if physical barriers prevent the diffusion of species, assume more or less one general facies. This passage, by aspect and type, of one stage in time into another is but scantily indicated at present in the uppermost manifestations of the palæozoic life and the lowermost of the mesozoic. The missing links will sooner or later reward the diligence of the geological explorer.

But, in the general aspect of the palæozoic world, contrasted with the worlds of life that followed, although all are evidently portions of one mighty organic whole, there seems to me to be something more than the contrast that depends on the loss or non-discovery of connecting links. There is more than we can explain by this theory. Granting for its support all facts capable of being so applied, there are residual phenomena to be accounted for, and which as yet have not been referred to any law that I know of.

For some years I have lived in hope of the discovery of a palæozoic fauna and flora more in accordance with those of after epochs than those we know, and fondly fancied that local differences of physical conditions alone might account for the discordance. But the fields opened by Murchison, Sedgwick, and Phillips, have been so extended, and have yielded such rich harvests at the hands of James Hall and his fellow-explorers in America, and of Barrande, de Koninck, de Verneuil, the Römers and Sandbergers, M'Coy, King, Salter, Roualt, and many other able palæontologists who have worked at palæozoic fossils in Europe, that it is becoming evident that we have before us a fair and true image of at least the marine aspect of the primeval group of faunas. The more they are investigated, the wider the ground is explored, the more striking is the difference in the main between the life palæozoic and the after-life.

Doubtless a principal element of this difference lies in *substitution*—in the replacement of one group by another, serving the same purpose in the world's economy. Paradoxical must be the mind of the man, a mind without eyes, who in the present state of research would deny the limitation of natural groups to greater or less, but in the main continuous, areas or sections of geological time. Now, that greater and lesser groups—genera, subgenera, families, and orders, as the case may be—or, in truer words, genera, of different grades of extent—have replaced others of similar value, and served the same purpose, or played the same part, is so evident to every naturalist acquainted with the geological distribution of animals and plants, that to quote instances would be waste of words. This replacement is *substitution of group for group*—a phenomenon strikingly conspicuous on a grand scale, when we contrast the palæozoic with the after faunas and floras. A single instance of these greater substitutions may be cited to assist my argument, viz., the substitution of the Lamellibranchiata of later epochs by the Palliobranchiata during the earlier. In this, as in numerous other instances, it is not a total replacement of one group by another that occurred; both groups were represented at all times; but as the one group approached a minimum in the development of specific and generic types, the other approached a maximum, and *vice versa*. I think few geologists and naturalists who have studied both the palæozoic and the after—I must coin a word—*neozoic* mollusca will doubt that a large portion of the earlier Brachiopoda—the Productidæ, for example —performed the offices and occupied the places of the shallower water ordinary bivalves of succeeding epochs.

Now in this substitution, the replacement is not necessarily that of a lower group in the scale of organization by a higher. There is an appearance of such a law in many instances that has led over and over again to erroneous doctrines about progression and development. The contrary may be the case. Now that we have learned the true affinities that exist between the Bryozoa and the Brachiopoda, we can see in these instances the *zoological* replacement of a higher by a lower group, whilst, in the former view, equally true, of the replacement of the Brachiopoda by the Lamellibranchiata, a higher group is substituted for a lower one. Numerous cases might be cited of both categories.

But can we not find something more in these replacements and interchanges than mere *substitution*, which is a phenomenon manifested among minor and major groups within every extended epoch? Is there no law to be discovered in the grand general grouping of the substitutions that characterize the palæozoic epoch, when contrasted with all after-epochs considered as one, the Neozoic? It seems to me that there is, and that the relation between them is one of contrast and opposition; in natural history, language is the relation of POLARITY.

The manifestation of this relation in organized nature is by contrasting developments in opposite directions. The well-known and often-cited instance of the opposition progress of the vegetable and animal series, each starting from the same point—the point at which the animal and vegetable organisms are scarcely if at all distinguishable—may serve to illustrate the idea, and make it plain to those to whom the use of the term POLARITY in geological science may not be familiar. In that case we speak of two groups being in the relation of polarity to each other, when the rudimentary forms of each are proximate, and their completer manifestations far apart. This relation is not to be confounded with divergence, nor with antagonism.

If we take the scale of geological formations, representing the succession of the leading divisions of time, and note for each of the epochs the known generic types present during its duration, we shall find there is not an equality of production, so to speak, at all times of fresh generic ideas. Genera have appeared, as it were, in batches. I am forced to use expressions that seem almost irreverent, and a phraseology of a loose and popular kind, in order to convey the more vividly my meaning. To talk of the appearance of a genus, that is, the appearance of an ideal type, is loose language, I am aware, but its meaning or intention can scarcely be misunderstood. In the individuals of a species only can we have the embodiment of a generic idea; but in discussing a question of the kind I am considering, it is convenient to use the word genus as if it were a realized unit and an entity. We speak, as it were, through a diagram. Now if commencing, upon our scale, at the dawn of the palæozoic epoch, and noting the beginning of genera or groups from the first known fauna up to the advent of man at the termination of the so-called tertiary epoch, we cannot fail to perceive the following general facts:—

1. During the earlier and middle stages of the palæozoic epoch, there was a great development of generic ideas.

2. During the middle and later stages of the neozoic epoch there was a great development of generic ideas.

3. During the terminating stages of the palæozoic epoch, the origination of generic ideas was very scantily manifested.

4. During the commencing stages of the neozoic epoch, the origination of generic ideas was very scantily manifested.

5. The majority of generic ideas that originated during the palæozoic epoch belong to groups (of various degrees of

generic intensity) which are characteristically palæozoic, *i. e.*, have their maximum development and variety during the palæozoic epoch, or else are even exclusively palæozoic.

6. The majority of generic ideas that originated during the neozoic epoch, belong to groups which are characteristically neozoic in the same manner.

7. The minimum development of generic ideas in time is at or about the passage or point of junction of the palæozoic and neozoic epochs.

8. Groups characteristically palæozoic swell out, as it were, in a direction *towards*, not from, the commencement of the palæozoic epoch.

9. Groups characteristically neozoic swell out in a direction *from* the commencement of the neozoic epoch.

That there are apparent exceptions to these general facts I do not pretend to deny; but the rules are so much more powerful than the exceptions, that we may safely wait with confidence for the explanation of the seeming anomalies during the course of the progress of research.

Now there is but one conclusion that can be drawn from these facts, if after being tested with every evidence now known to us, they remain intact as our science progresses. This conclusion is to the effect, that the relation between the palæozoic and neozoic life-assemblages is one of development in opposite directions, in other words of *Polarity*. In the demonstration of this relation, it seems to me that we shall, in all probability, discover the secret of the difference between the life anterior to the Trias and the life afterwards. The notion is in some degree a metaphysical one, but not the less capable of support through induction from the facts. I plead for its consideration, believing it to be worthy of earnest inquiry. I know that its novelty and seeming vagueness may repel many when it is thus briefly, and as if in outline, put forth. But before any geologist or naturalist rejects it, I would ask him to study carefully the admirable monographs, written without a bias, of whose merits I have been discoursing in this Address ; to seek out the manifestation of the idea, in the first instance, in some important and characteristic group of beings about whose time-distribution we have now a sufficient knowledge—such an assemblage as the Trilobites described to us in the work of Barrande, or the Brachiopoda as exhibited in the monograph by Davidson; to take and analyse the ample lists of extinct beings marshalled in the pages of Morris, or in the more general muster-rolls of Bronn and Alcide d'Orbigny; and then, having done this, to consider earnestly and fairly the idea that I have ventured to suggest of *the manifestation of Polarity in Time.*

On the Chemical Composition of Wernerite, and the Products of its Transmutation.

The minerals included under this name have recently been made the subject of an investigation, conducted in Rammelsberg's laboratory, by Gerhardt von Rath.* His object was to remove, as far as possible, the uncertainty which obtained with regard to the normal chemical composition of these minerals, and likewise to ascertain in what manner that composition is altered.

For the solution of the former question minerals were selected for analysis whose physical characters bore testimony to the conservation of their original nature. Decisive indications as to the latter question could only be obtained by the analysis of Wernerite which had evidently suffered transmutation. Those products of this process which differed most in chemical composition from the original mineral appeared best suited for this purpose, because analysis of them would make the nature of the change more clearly evident, and the possibility of its being concealed by the errors of analysis or the uncertainty as to the normal composition would be much lessened. For this reason definite individual mineral substances—mica, epidote—were selected for analysis, as well as substances which have neither a definite composition nor a distinctive form. All the substances analysed for this purpose presented the most unquestionable evidence that they were products of the transmutation of Wernerite—the crystal form of that mineral.

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* Annalen der Physik und Chemie. 1853. September and October.

Since only a few of the minerals examined were decomposed by hydrochloric acid, and as the estimation of both alkalies and silica was necessary, each analysis was double; the one by fusion with carbonate of soda, giving the percentage of silica, alumina with peroxide of iron, lime, and magnesia; the other by hydrofluoric acid, giving the percentage of potash and soda, together with that of alumina, peroxide of iron, lime, and magnesia. The results of the analysis by the former method are marked I., and of those by the latter II.; the mean results are marked III.

I. MEIONITE $(Ca\,O)_3\ Si\,O_3 + 2\ (Al_2\,O_3\ Si\,O_3)$.

The analysis of this mineral was undertaken first, because in the examination of Wernerite it appears to be the most appropriate starting point. Its physical characters admit of a positive inference that it is an unaltered mineral.

The crystals analysed occur, accompanied by green augite, and more rarely anorthite, in druses of granular limestone at Monte Somma. Their separation from anorthite is very tedious, and the discrepancies between the previous analysis of meionite are very probably owing to an admixture of that mineral. The density was 2·734 and 2·757. Hydrochloric acid decomposed the powdered mineral completely, but contrary to previous observations, the silica separated as a powder, not in a gelatinous state. Analysis gave:—

			Oxygen Ratio.	
Silica,	42·55		22·11	3·00
Alumina,	30·89	14·44	14·56	1·98
Peroxide of iron,	0·41	0·12		
Lime,	21·41	6·09	6·90	0·94
Magnesia,	0·83	0·33		
Potash,	0·93	0·16		
Soda,	1·25	0·32		
Volatilizable substance,	0·19			
	98·46			

This analysis gives an oxygen ratio which approximates so closely to 1 : 2 : 3, the one corresponding to the above formula, that, together with the results of Stromeyer and Wolff, there can no longer be any doubt as to the composition of meionite.

Epidote has likewise an oxygen ratio = 1 : 2 : 3 ; consequently it and meionite are heteromorphous substances, a circumstance which will require notice subsequently in speaking of the occurrence of epidote pseudomorphous of meionite.

II. SCAPOLITE $(Ro)_3$, $2\ Si\ O_3 + 2\ (R_2\ O_3\ Si\ O_3)$.

Oxygen ratio in Ro, $R_2\ O_3$, $Si\ O_3$ = 1 : 2 : 4.

1. *Blue Scapolite from Malsjo (Wermeland).*—Density 2·763. Occurs together with blackish green mica and green salite. Hydrochloric acid effects only a partial decomposition of this as well as all other scapolites. Analysis gave :—

	I.	II.	III.
Silica, ...	47·24	...	47·24
Alumina, . . .	24·19	25·19	24·69
Peroxide of iron, .	trace	trace	trace
Lime, ...	17·24	16·43	16·84
Magnesia, . . .	2·27	2·08	2·18
Potash, ...	...	0·85	0·85
Soda, ...	...	3·55	3.55
Water, ...	1·75	1·75	1.75
			97·10

The quantities of oxygen are :—

Silica, . . .	...	24·52	3·65	4
Alumina, . . .	...	11·54	1·72	1·86
Lime, . . .	4·79	6·71	1	1·09
Magnesia, . . .	0·87			
Potash, . . .	0·14			
Soda, . . .	0·91			

2. *White Scapolite from Malsjo.*—Density 2·658 ; occurs accompanied by salite and green hornblende in granular limestone.

The high per-centage of water, as well as the presence of carbonate of lime, imperceptible by the naked eye, are probably indicative of incipient decomposition. Analysis gave :—

	I.	II.	III.
Silica, . . .	49·36	...	49·36
Alumina, . .	25·19	25·47	25·33
Lime, . . .	12·73	12·22	12·47
Magnesia, . .	1·12	0·98	1·05
Potash, . .	...	1·51	1·51
Soda, ...	...	5·81	5·81
Water, . . .	2·47	2·47	2·47
Carbonate of Lime, .	1·35	1·35	1·35
			99·35

The quantities of oxygen are:—

Silica, . .	...	15·62	4
Alumina, . .	...	11·84	1·85
Lime, . . .	3.55	5·72	0·89
Magnesia, . .	0·42		
Potash, . .	0·26		
Soda, . . .	1·49		

3. *Glaucolite from Lake Baikal.*—Dark bluish-white. Density 2·666; but slightly decomposed by hydrochloric acid. It could not be determined whether the carbonate of lime was a product of alteration, or a primitive admixture. Analysis gave:—

	I.	II.	III.
Silica, . . .	46·01	...	46·01
Alumina,	27·73	27·20	26·72
Peroxide of Iron,		1·49	1·49
Lime, . . .	16·32	15·05	15·68
Magnesia, . .	0·42	0·48	0·46
Potash, . .	...	0·56	0·56
Soda, . . .	...	4.57	4.57
Water, . . .	0·47	0·47	0·47
Carbonate of Lime,	1·68	1·68	1·68
			97·64

The quantities of oxygen are:—

Silica, . .	...	23·88	4
Peroxide of Iron, .	0·44	12·93	2·16
Alumina, . .	12·49		
Lime, . . .	4·46	5·90	0·98
Magnesia, . .	0·18		
Potash, . .	0·09		
Soda, . . .	1·17		

4. *Compact Scapolite from Arendal.*—Pale yellowish green. Density 2·751. Gave off a bituminous smell when heated. Analysis gave :—

	I.	II.	III.
Silica, . . .	45·05	...	45·05
Alumina,	27·24	25·40	25·31
Peroxide of Iron,		2·02	2·02
Lime, . . .	17·67	16·93	17·30
Magnesia, . .	0·32	0·29	0·30
Potash, . . .	...	1·55	1 55
Soda, ...	...	6 45	6·45
Volatile substance, .	1·24	1·24	1·24
			99·22

The quantities of oxygen are :—

Silica, . . .		23·38	4
Alumina, .	11·83	12·44	2·12
Peroxide of Iron, .	0·61		
Lime, . . .	4·92	6 95	1·10
Magnesia, . .	0·12		
Potash, . .	0·26		
Soda, . . .	1·65		

5. *Nuttalite, from Boston, Massachusetts.*—Grayish-black crystals. Density 2·748. Analysis gave :—

	I.	II. *a.*	II. *b.*	III.
Silica, . . .	45·57	...	...	45·57
Alumina,	27 47	23·91	23·38	23·65
Peroxide of Iron,		3·59	3·17	3 38
Lime, . . .	20·66	20.64	21·14	20·81
Magnesia, . .	1·31	1·72	1·12	1·23
Potash, . . .	...	...	0·63	0·63
Soda, ...	...	...	2·46	2·46
Water, . .	0·78	0·78	0·78	0·78
				98·51

The analyses I. and II. *a.* refer to exactly the same material, II. *b.* to very carefully selected fragments.

The quantities of oxygen are :—

Silica, . . .		23·75	4
Alumina, . .	11·05	12·06	2·03
Peroxide of Iron, .	1·01		

Lime,	5·92	7·15	1·20
Magnesia,	0·49		
Potash,	0·11		
Soda,	0·63		

This mineral agreed perfectly in all its physical characters with that mentioned by Brooke and analysed by Thomson, who found that it contained protoxide of iron, and, unlike the generality of scapolite, no soda.

6. *Nuttalite from Bolton.*—Physical character like the former. Density 2·788. When heated they gave out the same bituminous smell as the Arendal scapolite. Analysis gave:—

	I.	II.	II.
Silica,	44·40	...	44·40
Alumina,	29·50	25·28	25·52
Peroxide of Iron,		3·79	3·79
Lime,	19·88	20·48	20·18
Magnesia,	0·93	1·08	1·01
Potash,	...	0.51	0·51
Soda,	...	2·09	2·09
Water,	1·24	1·24	1·24
			98 74

The quantities of oxygen are:—

Silica,	...	22·04	4
Alumina,	11·93	13·04	2·26
Peroxide of Iron,	1.11		
Lime,	5·74	6·76	1·17
Magnesia,	0·40		
Potash,	0·09		
Soda,	0·53		

7. *Prismatic Scapolite from Arendal.*—Occurs in the magnetite beds of Arendal, together with the compact scapolite (4), and imbedded in limestone. Colour greenish-yellow. Density, 3·697. Analysis gave—

	I.	II.	III.
Silica,	46·82	...	46·82
Alumina,	27·33	26·29	26·12
Peroxide of iron,		1·39	1·39
Lime,	16·83	17·63	17·23

Magnesia, . .	0·24	80·26	0·2
Potash, . .	...	0·97	0·97
Soda, . .	...	6·88	6·88
Volatile substances,	0·33	0·33	0·33
			100·00

The quantities of oxygen are—

Silica, . .	...	24·32	4·
Alumina, . .	12·21	12·63	2·07
Peroxide of iron,	0·42		
Lime, . .	4·90	6·92	1·13
Potash, . .	0·10		
Soda, . .	0·16		
Volatile substances,	1·76		

The composition of this mineral is therefore identical with that of the compact variety (4) from the same place.

For the purpose of a general comparison of the composition of the above varieties of scapolite, the author has tabulated the oxygen ratios obtained from the analytical results, together with the deviations from that corresponding to the formula RO, R_2O_3, $Si\,O_3$ and the densities:—

				Differences.		Densities.
	$Si\,O_3$	$R_2\,O_3$	$R\,O$	$R_2\,O_3$	$R\,O$	
Blue scapolite (Malsjo),	4	: 1·84 :	0·93	− 0·16	− 0·07	2·763
White do. do.	4	: 1·86 :	1·09	− 0·14	+ 0·09	2·658
Glaucolite (Baikal),	4	: 2·16 :	0·48	+ 0·16	− 0·02	2·666
Compact scapolite (Arendal),	4	: 2·12 :	1·19	+ 0·12	+ 0·19	2·751
Prismatic scapolite,	4	: 2·07 :	1·13	+ 0·07	+ 0·13	2·697
Nuttalite, .	4	: 2·03 :	1·20	+ 0·03	+ 0·20	2·748
„	4	: 2·27 :	1·17	+ 0·26	+ 0·17	2·788

It is hence evident, that the oxygen ratios corresponding to the composition of varieties of scapolite, differ as much from that of the formula $(\dot{R}\,O)_3$, $2\,Si\,O_3 + 2\,R_2\,O_3$, viz.,—1 : 2 : 4, as Rammelsberg found it to be the case in the varieties of ekebergite. The differences have mostly a positive value; the proportion of bases is somewhat greater than that corresponding to the formula. Rammelsberg found this to be the case with regard to the bases $R_2\,O_3$, while the proportion of bases RO was observed to be less than that corresponding to the formula.

The deviations from the formula, whether positive or negative in their value, which are indicated by these analyses as well as by those of Rammelsberg, are, however, by no means so great as to admit of a doubt that the true oxygen ratio of scapolite is 1 : 2 : 4; and in a subsequent part of the memoir, alterative processes are pointed out which tend to increase the percentage of silica, as well as others, wholly different, which increase the percentage of bases.

III. ABNORMAL WERNERITE,

$$3\,(RO,\ SiO_3) + 2\,R_2O_3,\ SiO_3.$$

The author gives analyses of two varieties of Wernerite, whose composition does not appear to correspond with either of the formulæ proposed by Rammelsberg.

1. *Wernerite from Gouvernour, New York.*—Occurs in fine crystals, imbedded in calcite; colourless, and more or less transparent. Density 2·633. Analysis gave—

	I.	II.	III.
Silica,	52·25	...	52·25
Alumina,	23·92	24·02	23·97
Peroxide of iron,	trace	trace	trace
Lime,	9·85	9·87	9·86
Magnesia,	0·68	0·91	0·78
Potash,	...	1·73	1·73
Soda,	...	8·70	8·70
Volatile substances,	1·20	1·20	1·20
			98·49

The quantities of oxygen are—

Silica,	...	27·12	5·
Alumina,	...	11·20	2·06
Peroxide of iron,	trace	trace	trace
Lime,	2·80	5·62	1·03
Magnesia,	0·31		
Potash,	0·29		
Soda,	2·22		

So far as it is possible to judge from the exterior appearance and physical character, this mineral was in a perfectly unaltered state. This opinion is likewise confirmed through the analysis, by the absence of peroxide of iron which is always introduced during alteration, and by the high percentage of soda, which, so far as the author's analyses extend, is never met with in decomposed Wernerite. He considers the oxygen ratio for this mineral to be 1 : 2 : 5. If further analyses of minerals from this locality should confirm the formula assigned to this variety of Wernerite, it must be regarded as a distinct species, which would be characterized by—1. the simple oxygen ratio; 2. the high percentage of silica; 3. the small percentage of alumina; 4. the comparatively small percentage of lime and high percentage of alkalies, amounting on the whole to 10·5.

2. *Wernerite from Pargas (Finland.)*—Occurs together with black and green augite, and small granules of apatite, imbedded in calcite. Colour greenish. Density 2·654. The powder is completely decomposed by hydrochloric acid. Analysis gave :—

Silica, . .	45·46		25·59	4·
Alumina, .	30·96		14·94	2·48
Peroxide of iron,	trace			
Lime, . .	17·22	4·90	5·70	0·97
Magnesia, .	...	...		
Potash, . .	1·31	0·22		
Soda, . .	2·29	9·58		
Water, . .	1·29			
	98·53			

This Wernerite has been analysed by Nordenskiöld, who found the oxygen ratio for $RO : R_2 O_3 : Si O_3 = 0·95 : 29 : 4$, and by Wolff, who found it $= 0·9 : 26 : 4$.

Wolff's analysis and that of the author present a tolerable agreement, particularly in the oxygen ratios, according to which the Wernerite of Pargas must be regarded as a distinct species, having the formula—

$$3\,(RO)_2\,Si\,O_3 + 5\,Q_2\,O_3\,Si\,O_3.$$

PSEUDOMORPHOUS DERIVATIVES OF WERNERITE.

Under this head are considered substances which possess the crystal form of Wernerite, but an essentially distinct chemical composition.

A. SUBSTITUTION OF POTASH FOR SODA.

1.—*Pseudomorphous Mica after Wernerite.*

At Arendal large Wernerite crystals occur in quartz. Their surface is entirely covered with scales of mica, and the substance of the crystals consists, moreover, entirely of the same mica, intermixed with quartz, small crystals of pinguite, and sometimes a soft green substance, which appears to be intermediate between Wernerite and mica. The mica is greenish white and transparent. Its density is 2·833. Analysis gave:

	I.	II.	III.
Silica,	44·49	...	44·49
Alumina,	29·32	25·35	24·91
Peroxide of iron,		4·84	4·84
Lime,	1·91	2·37	2·14
Magnesia,	0·21	0·50	0·36
Potash,	...	6·71	6·71
Soda,	...	1·11	1·11
Water,	3·44	3·44	3·44
Carbonate of Lime,	11·11	11·11	11·11

The quantities of oxygen are,—

Silica,		25·09	4
Alumina,	10·84	12·29	2·12
Peroxide of iron,	1·45		
Lime,	0.61	2·17	0·38
Magnesia,	0·14		
Potash,	1·14		
Soda,	0·28		
Water,	3·06		

The analysis of this pseudomorphous mica shews that it differs from other potash mica, especially in the large proportion of bases RO to those $R_2 O_3$; and in the large proportion of silica to the two classes of bases. The formula expressing its composition is:—

$$KO, Si O_3 + 2 Al_2 O_3 Si O_3$$

And the oxygen ratio for $KO : Al_2 O_3 : Si O_3 = 1 : 6 : 9$.

Comparing the composition of this mineral with that of scapolite, it will be seen that the proportion between the silica and the weaker bases is much the same; while the proportion between it and the mono-atomic bases is widely different. Their total quantity of oxygen is little more than a third of what it is in scapolite; the quantity of magnesia is very small; that of soda less even than in meionite, while the quantity of potash is as great as in the generality of mica. In order to form an idea of the mode in which this mica has been produced, it is assumed that the original mineral in this instance was scapolite, whose composition agreed with the formula—

$$(Na\,O + 2\,Ca\,O)\,2\,Si\,O_3 + 2\,(Al_2\,O_{30}\,Si\,O_3).$$

which represents the composition of the Arendal Wernerite, and indeed almost all those from Scandinavia and America, which have been examined. Since the perfect Wernerites do not contain any, or at the most only a trace, of peroxide of iron, while the altered Wernerite always contains a more or less considerable quantity, it is allowable to infer that alumina is the only weaker base in the normal composition. By comparing this assumed original composition (I.) with that of the pseudomorphous mica, (II.) expressed centesimally without reference to the water, or carbonate of lime,—

		I.		II.
Silica, .	4	49·5		52·63
Alumina, .	2	27·5		29·46
			Peroxide of iron, .	5·72
Lime, .	2	15·0		2·52
			Magnesia, . .	0·43
Soda, .	1	8·0	. . . .	1·30
			Potash, . .	7·94
		100·0		100·00

there appears a striking similarity between the proportions of silica and alumina in the two cases. Instead, however, of the soda in the original mineral, the mica contains almost exactly the same quantity of potash, besides a small quantity of soda. The original mineral would lose 12·48 per cent, of its mass, and receive in its place 5·72 peroxide of iron, 0·43 magnesia, 1·3 soda, making together only 7·45 per cent.; and as the mica is denser than the generality of scapolite, the change would be attended with diminution of volume.

Assuming, then, that in the production of this mica the relative proportion of silica and alumina suffered no alteration, the essential features of the change would be limited to—

1. The abstraction of lime,
2. The introduction of peroxide of iron, and
3. The substitution of potash for soda.

We are ignorant of any other mode in which this transmutation could be effected than by the agency of the surface water, which is continually penetrating through the earth's strata, and which always contains more or less of the substances which come into play in this case,—lime, oxide of iron, potash, and soda.

So far as classification is at all applicable to natural phenomena, there appears to be no doubt that the transmutations which take place in the above manner in inorganic nature, must be separated into such as result from the solvent action of water alone, and such as are in a great degree owing to the carbonic acid which it holds in solution. The decomposition of felspar and other alkaline silicates is an example of the former class. The decomposition of calcareous silicates, requiring the conjoint agency of carbonic acid, is an example of the latter class. There is every reason to believe that, when water containing carbonic acid, even in so small proportion as meteoric water, comes into contact with calcareous silicates, they are decomposed the more readily the greater their percentage of lime. Now, as scapolite contains both lime and alkali, it might be inferred that both these decompositions would take place together, but it seems that the process is more complicated.

One of the substances most frequently present in the water of springs is protocarbonate of iron. The gas dissolved in such water almost always contains nitrogen in larger proportion than the atmosphere; oxygen in much smaller proportion, although, according to the solubility of these gases, a contrary relation would obtain. This appears to indicate an abstraction of oxygen from the dissolved gas, and a consequent peroxidation of the iron, which would account for the introduction of peroxide of iron into the scapolite. The carbonic acid, liberated at the same time, would attack the lime and remove it in the state of bicarbonate.

The substitution of potash for soda is far more difficult to account for. Supposing a mineral, containing silicate of soda, to be continuously exposed to the influence of a liquid containing carbonate of potash, some probability attaches to the assumption that, by a mutual decomposition, soda would pass into solution as carbonate, while potash would enter into the composition of the mineral as silicate.

There are a number of other phenomena of pseudomorphism which indicate a substitution of potash for soda. For instance, pseudomorphous mica in the form of nephelin. The latter mineral contains 15 or 16 per cent. of soda, and only 5 or 6 per cent. of potash; so that, under the circumstances assumed for the transmutation of Wernerite, soda must be abstracted, and potash introduced, for there is seldom less than 8 per cent. of potash in mica. Unfortunately, however, the mica, in the form of nephelin, has never been analysed.

The above-mentioned pseudomorphous mica occurs in beds of magnetite, associated with gneiss, at Arendal. If we suppose that meteoric water, penetrating through the gneiss and magnetite beds, takes up, by means of its carbonic acid, both alkalies and protoxide of iron, the potash preponderating as much over the soda in the solution as it does in the gneiss, the conditions favourable for the conversion of scapolite into mica by the process described would exist.

It appears, however, that all investigation of these and analogous phenomena must be limited to ascertaining processes by which it is possible that the observed changes may have been effected.

2. *Yellow Scapolite, from Bolton, Massachusetts.*

The physical character of this mineral afforded unmistakeable indications of alteration. Density, 2·787; colour, pale yellow. Carbonate of lime was not visible to the eye. Analysis gave—

	I.	II.	III.
Silica, . . .	49·99	...	49·99
Alumina, .	24·25	23·41	23·01
Peroxide of iron,		1·64	1·64
Lime, . . .	3·74	2·95	3·35
Magnesia, . .	1·00	1·66	1·73
Potash, . .	...	7·06	7·09

Soda, . . .	...	0·35	0·35
Water, . . .	4·23	4·23	4·23
Carbonate of lime, .	7·80	7·80	7·80
			99·19

The quantities of oxygen being—

Silica, . . .		25·94	4
Alumina, . .	10·75	11·19	1·73
Peroxide of iron, .	44		
Lime, . . .	95	2·93	0·45
Magnesia, . .	69		
Potash, . . .	1.26		
Soda, . . .	0·09		
Water, . . .	3·76		0·58

This scapolite differs, like the mica, from the other minerals in the oxygen ratio of $Si\,O_3$ and RO. The quantity of the mono-atomic bases is, as in the mica, less than that corresponding to the formula $(RO)_3\,2\,Si\,O_3 + 2\,(R_2\,O_3\,Si\,O_3)$. Moreover, the quantity of the bases $R_2\,O_3$ is less, that of water, greater than in the other minerals. Apart from the physical characters, the advanced alteration of this mineral is indicated by the high percentage of silica, the small percentage of lime, and the large quantity of water it contains. There is indeed a remarkable similarity between its composition and that of the mica.

Comparing as before its percentage composition I. with that assumed to represent the original scapolite II.—

	I.	II.
Silica, . . .	57·20	49·5
Alumina, . .	26·35	27·5
Peroxide of iron, .	1·88	
Lime, . . .	3·84	15·0
Magnesia, . .	1·98	
Potash, . .	8·34	
Soda, . . .	0·41	8·0
	100·000	100·000

it appears that while scapolite generally contains three or four times as much soda as potash, this altered mineral contains twenty times as much potash as soda; magnesia is present in nearly double the quantity that is found in unaltered scapolite. It appears, likewise, that alumina has been removed, for the percentage is lower than any of the other minerals, the oxygen ratio of $Si\,O_3 : R_2\,O_3$ being 4 : 1·73; but it is difficult to perceive in what manner this has taken place. There is likewise a remarkable deficiency of peroxide of iron, compared with other altered scapolites.

The fact that this mineral has so closely the composition of mica, and yet is not, like the last mentioned, converted into it, is very curious.

3. *Red Scapolite from Arendal.*

Density 2·852. Evidently much altered. Occurs together with black hornblende in the magnetite beds of Arendal. Analysis gave:—

	I.	II.	III.
Silica,	59·74	...	59·74
Alumina,	23·86	16·44	16·20
Peroxide of iron,	...	7·90	7·90
Lime,	2·24	2·05	2·15
Magnesia,	3·90	4·15	4·02
Potash,	—	4·42	4·42
Soda,	—	4·31	4·31
Water,	1·83	1·83	1·83
			100·57

The quantities of oxygen being—

Silica,		31·00	4
Alumina,	7·57	9·95	1·28
Peroxide of iron,	2·37		
Lime,	0·61	4·12	0·53
Magnesia,	1·66		
Potash,	0·75		
Soda,	1·10		

This mineral is distinguished by a maximum of silica and a percentage of lime less even than in mica. It is remarkable that magnesia, potash, and soda, are present in the same proportion. The smaller proportion of bases $R_2\,O_3$, and the preponderance of potash over soda, is likewise evident.

The substitution of potash for soda appears, therefore, as the characteristic feature of this transmutation. Out of forty specimens of Wernerite, to all appearance unaltered, analysis shewed that in thirty-eight the quantity of potash was very small in proportion to the soda, while in five out of seven specimens of decomposed Wernerite, potash was found to predominate over the soda.

The composition of the red Wernerite is further remarkable from the presence of a larger quantity of magnesia than has yet been met with in these minerals. This earth undoubtedly plays a very important part in the transmutation of minerals, as is sufficiently evidenced by the great varieties of pseudomorphous steatite, talc, and chlorite, together with the fact that bicarbonate of magnesia and silicate of lime undergo a mutual interchange of constituents. Rose found that a number of altered augites (salite) always shewed an increase in the proportions of silica and magnesia, together with a decrease of lime.

B. SUBSTITUTION OF MAGNESIA FOR ALKALIES.

Black Scapolite from Arendal.

The crystals were very soft and without any trace of cleavage. Density, 2·837. Analysis gave—

	I.	II.	III.
Silica,	29·52	—	29·52
Alumina,	15·41	16·13	15·77
Peroxide of iron,	19·25	19·03	19·14
Lime,	8·94	9·10	9·02
Magnesia,	—	8·50	8·50
Potash,	—	0·37	0·37
Soda,	—	0·58	0·58
Water and bitumen,	10·89	10·89	10·89
Carbonate of lime,	4·62	4·62	4·62
			98·45

The quantities of oxygen being—

Silica,		15·32	4
Alumina,	7·37	13·11	3·42
Peroxide of iron,	5·74		
Lime,	2·56	6·19	1·62
Magnesia,	3·42		
Potash,	0·06		
Soda,	0·15		
Water,		9·68	2·52

In the composition of this mineral the proportion between the bases RO and R_2 O_2, is not essentially different from that found in the unaltered mineral; the percentage of silica is, however, very much lower than in any other instance, so that the change would appear to have been effected in a manner different from that above described.

The proportion of alumina to silica is nearly 1 : 2, while in unaltered scapolite the quantity of silica is always rather less than double that of alumina. If, then, we assume that the absolute quantity of alumina has not been altered, the increase of silica may be regarded as the consequence of the introduction of silicate of magnesia. As regards the bases, the difference between the composition of this mineral and that of unaltered scapolite consists in the large proportion of peroxide of iron and magnesia, with the small proportion of alkalies. The introduction of so large a quantity of peroxide of iron would necessarily reduce the relative proportion of silica and alumina. The composition of this mineral therefore indicates:—

An absolute increase in the qualities of . .	$Si\,O_3$, $F_2\,O_3$, $Mg\,O$
An absolute diminution of	$Ca\,O$, (KO), $Na\,O$.
A relative increase of .	$F_2\,O_3$, $Mg\,O$
A relative diminution of	$Si\,O_3$, $Al_2\,O_3$, KO, $Na\,O$ $Ca\,O$.

The nature of this change would appear to indicate circumstances altogether different from those before assumed, and it serves to shew that the explanation of pseudomorphic phenomena would require a much more intimate knowledge of the locality in which the minerals occur than is often attainable.

C. SUBSTITUTION OF LIME FOR ALKALIES.

Epidote in the form of Wernerite (from Arendal).

The substance of the crystals presented all the physical characters of pistacite. Density 3·223. Analysis gave—

	I.	II.	III.
Silica, . .	37·92	—	37·92
Alumina, .	34·99	19·09	19·21
Peroxide of iron,		15·55	15·55
Lime, . . .	22·94	22·42	22·68
Magnesia, . .	0·19	0·31	0·25
Potash, . .	—	0·23	23
Soda, . .	—	0·39	39
Water, . .	2·51	2·51	2·25
			98·74

The quantities of oxygen were—

Silica,	—	20·06	3
Alumina,	8·98	13·64	2·03
Peroxide of iron,	4·86		
Lime,	6·45	6·70	1·00
Magnesia,	0·10		
Potash,	0·04		
Soda,	0·11		

The composition of this mineral agrees with the general formula proposed by Rammelsberg for epidote more closely than any hitherto analysed.

Among the pseudomorphous substances produced by an interchange of constituents, the number of instances in which the product of alteration is a double silicate is very small. Apart from the remarkable pseudomorphous felspar recently discovered, and the pseudomorphous zeolites, the only double silicates which occur as pseudomorphous are mica, hornblende, chlorite, and epidote. The first two vary so much in their composition that they can scarcely be regarded as double silicates, of definite simple constitution, so that there remain only the pseudomorphous chlorite and pseudomorphous epidote, in the forms of garnet and Wernerite. The compositions of these latter minerals possess a certain similarity. Their formulæ are :—

Meionite, . $RO\ Si\,O_3 + 2\ R_2\,O_3\ Si\,O_3$
Garnet, . $RO\ Si\,O_3 + \cdot\ R_2\,O_3\ Si\,O_3$

Pseudomorphous epidote occurs only in the forms of these two minerals, and it might be supposed that the similarity in their composition would furnish some clue to the mode of alteration. Thus meionite and zoisite being heteromorphic substances, it might be assumed that the conversion of the former into the latter consists in a physical re-arrangement of the molecules, attended with an increase of density. This cannot, however, be the case, and for the following reasons :—

1. Although zoisite and meionite are identical in composition, pistacite and meionite are not; meionite does not contain peroxide of iron, while in pistacite it seldom amounts to less than 10 per cent.

2. There is nothing to justify the opinion, that the origi-

nal Wernerite, from which the pseudomorphous epidote was produced, had a composition represented by the formula of meionite; for with the exception of the mineral from Vesuvius, no Wernerite is known whose composition approaches at all near to it.

The only possible inference therefore, is, that the change has been effected by a substitution of the constituents of a scapolite. In order to clear up this point, an analysis was made of a scapolite resembling the prismatic scapolite (7), which had been partially converted into epidote:—

	I.	II.	III.
Silica, .	43·41	46·82	37.92
Peroxide of iron,	8·68	1·39	15·55
Potash, .	0·72	0·97	0·23
Soda, .	3·24	6·88	0·39

A mixture of equal parts of the scapolite (7) and epidote, would give an analysis:—

Silica, ...	42·37
Peroxide of iron, ...	8·47
Potash, ...	0·60
Soda, ...	3·63

Numbers which correspond very closely with I.

There can be little doubt, therefore, that the pseudomorphous epidote was produced by chemical alteration of the scapolite substance. Now, it is customary to assume that when a calcareous mineral suffers alteration, the result is an abstraction of lime, and a relative increase of silica. But this pseudomorphous epidote presents an example of the contrary; the percentage of silica is less, that of lime greater. The larger proportion of lime cannot be ascribed to an abstraction of other constituents; it must have been actually introduced, for the epidote mass is compact, free from cavities, and appears perfectly homogeneous.

From the results of this and previous investigations of Wernerite, the following conclusions may be drawn as to its chemical history:—

I. With regard to the normal constitution, there appears to be several heteromeric species:—

		Oxygen Ratio. $RO : R_2O_3 : SiO_3$
Meionite,	$(CaO_3)\ Si\ O_3 + 2\ Al_2\ O_3\ Si\ O_3$.	$= 1 : 2 : 3$
Scapolite,	$(CaO,\ NaO_3)\ 2\ Si\ O_3 + 2\ Al_2\ O_3\ Si\ O_3$	$= 1 : 2 : 4$
Wernerite, (Gouvernour,)	$(CaO, NaO_3)\ 3\ SiO_3 + 2\ Al_2O_3\ SiO_3$	$= 1 : 2 : 5$
Wernerite, (Pargas),	$3\ (CaO, NaO_2)\ SiO_3 + 5\ Al_2O_3\ SiO_3$	$= 1 : 2{\cdot}5 : 4$
5. Nuttalite, .	$RO\ SiO_3 + Al_2O_3\ SiO_3$.	$= 1 : 3 : 6$

The essential constituents of the original species appear to be :—

Soda.
Lime.
Alumina.
Silica.

II. In the transmutation of Wernerite, the following changes take place,—

Introduced.		Abstracted.	
1. Potash, .	(3)	5. Soda, .	(6)
2. Magnesia, .	(3)	6. Lime, .	(5)
3. Lime, .	(1)	7. Alumina, .	(4)
4. Peroxide of iron,	(5)		

The quantity of silica is relatively increased or diminished; whether any absolute alteration takes place, is difficult to determine.

These changes take place together in various ways :—

1, 4, 5, 6, determine the conversion into . . mica.
1, 2, 4, 5, 6, 7, . . red and yellow Wernerite.
2, 4, 5, 6, 7, . . . black Wernerite.
3, 4, 5, ... epidote.
5, 6, 7, ... Wernerite with 92·7 prt SiO_3

The small numbers in brackets indicate the probable relative frequency of the changes.

B. H. P.

On the Palolo. Communicated by the Rev. Mr Gill, Missionary, in a Letter to R. Chambers, Esq.

One of the natural curiosities of the South Pacific Islands is the *Palolo.*

The *Palolo* is the native name given by the Samoa islanders to a sea-worm, which appears *regularly* every year, near to a few of the boat-openings in the great barrier reef round the islands of Upolo and Savaii, the two largest islands of the Samoa group.

There are many singularities connected with the Palolo, calculated to excite attention and to demand investigation.

1. The time of its appearance.

It invariably appears on the morning of the day when the moon *enters* her last quarter, either in the month of October, if the moon quarters late in that month, or if not, it occurs in November; and this at the same time every year. A few of the Palolo may be seen on the previous morning, but the day of the moon's quartering is the grand day. After that forenoon not the least vestige is to be seen until that day in the following year. They appear in great quantities about the dawn of day, and continue on the surface of the sea until the sun is about two hours high above the horizon; they then break up into small fragments, dissolve into a yellow creamy matter, having to all appearance fulfilled their destiny.

2. The worm is found swimming in a spiral form, as if at random, often singly, but generally collected in shoals. They vary in length, from a few inches to two and three feet. In thickness none exceed the eighth of an inch, and the segments number according to the length of the animal.

It has long hairs along each side, so that, with the exception of the head, it is not much unlike the *Geophilus longicornis*, or the *Scolopendra electrica* of Linn. The head is something like that of an earthworm. In colour they vary; brown, blue, and green of all shades.

3. Not the least singular fact connected with their appearance is the difficulty of ascertaining from whence they come. None are found *outside* the barrier reef, but always inside, in

water three or four fathoms deep. The natives say, they come from seaward, but can give no reason for this conjecture. After many years' close observation, writes the Rev. W. Mills, I am still unable to decide; but from the suddenness with which they gather into clusters, I am inclined to think they rise from the bottom. The question then is: Is it one of the many *Polypifera* which are employed in constructing the coral, and which at that particular time escape from its many ramifications?

The objections to this supposition are, *first*, That the Palolo is to be found at a *very few places*, not more than three or four in all the great extent of reef surrounding this island; whereas if it belonged to coral, it might be expected to appear at other places; unless it belong to some particular kind of coral, only found at those places where the Palolo appears; of the existence of which, however, there is no evidence. *Secondly*, The animal, when complete, terminates rounded at both ends, having no *tentacula* with which the coral building Polypifera are possessed to operate round the mouth of their cells.

The natives calculate with great certainty the day the Palolo appears, and are never mistaken in their calculations. They go out in their canoes, each person having a basket, and with this he skims up the animal as it swims on the surface. It is cooked, and esteemed a great dainty. Those natives fortunate enough to secure it, carry it to their friends round the island, who live where it does not appear. From the day of its appearance the natives begin the six months, which they call *Vae Palolo*, or winter season. We have no instance on any of the other islands of this animal being found; yet on most of the land in the east the winter season is called *Palolo* or *Paroro*.

A Suggestive Paper on the Palæozoic Formations of the Earth. By E. Pughe, B.A., Vicar of Bangor Cathedral. Communicated by the Author.

The prevailing opinion relative to the Mosaic account of the creation, appears to me to be this: That it undertakes to represent that event as *a phase in this world's existence,* rather than as its *genesis* from chaos, or its *original* formation into its present planetary state,—the crowning event in that phase or development being the creation of man.

But the recent discoveries in geological science as to the different strata of the earth, and the existence therein of palæozoic remains, fossils, and flora, together with the inconceivably long epochs required in order to the solidifying of such formations, are as perplexing to the mind, as they are irreconcilable with the less learned, but more generally received, notions of the Mosaic theory.

A new and somewhat easier solution of this difficulty has presented itself to my mind; and inasmuch as it militates not against the Inspired account, or the traditional notions of mankind on the subject, I humbly submit it to your more experienced readers, in order that, on scientific principles its probability may be tested.

The first and most prominent point in the Inspired Record, is, that "the earth" (the *materiel,* I apprehend, from which the earth was created) "was without form and void,"—formless and opaque—a description that accords with our notions of the chaotic state of matters previous to the planetary formation of this earth; "and the Spirit of God moved upon the face of the water,"—so moved upon it that by the powerful action of that element, teeming perhaps like its kindred chaotic substances with indigenous organic remains (a process which would account for marine strata in high altitudes, and increase the probability of *drifts*), the earth, as part of the solar system, which it *was not* previously, assumed its present spheroidal and illuminated form.

But the hypothesis, which I would further suggest in order to the solution of geological difficulties, and their perfect reconcilableness with the Mosaic record, is this: Let us suppose the *materiel* above mentioned to consist of fragmentary portions of other planets (one or more) which, having discharged their functions in other spheres, contained in them (modified according to the transitional laws to which meanwhile they might have been subjected) the stratified remains of such animals and productions as *had* lived or grown upon them in different cycles of space and time; and that from the aggregation of such materials the outer incrustations or strata of this earth were consolidated. If we admit this theory, the embarrassingly long epochs assigned to the solidifying process of the earth's formations become more naturally reconcilable to our own perceptions, and easier of solution, comparatively speaking, as the result of *foreign* and *extrinsical* action—distant as to time and space; and such as, on the supposition that this globe (as such) existed for ages before the creation of man, it would be difficult to harmonize with the Inspired Narrative; in such case, too, no obstacle will present itself to the unqualified reception of that account as the simple record of this earth's *original formation*, and of that event being contemporaneous with the creation of man.

We may further observe, if this hypothesis be admitted, that it will furnish corroborative proof of the existence of distinct species of animal and vegetable life in other spheres, subject, as to its gradations and developments, to the laws both physical and atmospheric, under which it may exist; and is there not much in the fossil remains of animals which we denominate *extinct* (and if extinct, how came they to be so?), that may be considered indicative of a foreign origin and of physical properties unsuited in many respects to our own planetary atmosphere and position? The theory of aërolites, combined with other discoveries, astronomical as well as geological, raises a presumption in favour of the existence of external matter, and the not impossible formation of this globe from the fusion of adventitious accretions; while the action of heat visible in the primeval strata leads also to the supposition, that the materials of which the earth consists may have been the fragmentary accumulations of worlds dissolved by fire precisely as our own world will in due time be dissolved, to be succeeded in its turn (ἐν τῇ παλιγγενεσίᾳ) by "new heavens and a new earth, wherein dwelleth righteousness."

The Tides in South Pacific. Communicated by the Rev. Mr GILL, Missionary, in a Letter to ROBERT CHAMBERS, Esq.

The following paper was prepared by one of our missionaries, and printed in a paper of missionary information for private circulation. The subject is one of interest; and, thinking it not likely you have seen it, I enclose it.

In no part of the world is the same deviation to be observed in the phenomena of the tides as is seen in Tahiti, and the adjacent islands of that group;—1st, in respect to the very limited rise and fall, which is not more than from fifteen to eighteen inches. In this it is quite unique, except in some inland seas. 2d, In not being regulated by the moon, except in a small degree—high-water seldom extending beyond an hour before and after noon. "This is so well established," says Mr Ellis, "that the time of night is marked by the ebbing and flowing of the tide." This singularity is to be observed in no other part of the Pacific, nor any other sea, that I am aware of.

This fact is not of recent discovery; it was known to the missionaries soon after they settled there, more than fifty years ago. It does not appear, however, that the anomaly was known to any of the early navigators; at least, there is no mention made of it in the voyages of Wallis, Cook, or Bligh. Captain Cook, indeed, observed and recorded the limited rise and fall at Point Venus, or Matavai Bay, to be from ten to twelve inches (folio edit., p. 29), but does not seem to have taken notice of the unvarying time of the ebb and flow. In a recent number of the *Athenæum* (September 1850, p. 957), there is a notice, to the effect that an American captain, who had just returned, had verified the fact, by getting the affidavits of two respectable residents. The captain might have known, as well as the editor of the Journal, that the fact was confirmed many years ago by men of science, English, French, and American, who had visited Tahiti.

Singular as the thing is, and though made a matter of observation by every scientific expedition visiting the group, yet it is remarkable that no attempt seems to have been made to explain the phenomena. A departure from a general law surely deserves to be investigated.

My object is to shew that this deviation has led many writers into mistakes respecting the tides of the Pacific. Many have taken it for granted that the same prevails over every part of this ocean; whereas, with the exception of Tahiti and the islands near to it, the tides in the South Seas are as much regulated by the moon as in any other part of the world. The author of "A Million of Facts," in trying to establish a theory of his own, in opposition to that of Sir Isaac Newton, boldly asserts, that the moon has no attractive influence on this ocean; in short, that no tide is to be observed. Even in the able article on the "Tidewave," in the *Penny Cyclopædia*, it is observed, that the height of the tides in the South Seas are small, not exceeding two feet. Now, this is far from being in accordance with reality. At this group, at the low islands to the north of this, near the equator; the Hervey Islands, to the south; the Tonga, Fijii, New Hebrides, Loyalty, and other groups, the average rise and fall is not less than four feet six inches. In the account of the Friendly Islands in "Cook's Voyages," we find the following note:—"At these islands the tides are more considerable than at any other of Captain Cook's discoveries in this ocean, that are situated within either tropics. At Annamooka, it is high water near six o'clock, on the full and change of the moon; and the tide rises and falls about six feet upon a perpendicular. In the harbour of Tongataboo, the tide rises and falls four feet and a half at the quadratures:" (folio edit., p. 479). There may be a difference in the co-tidal lines; but at all these islands which form points of observation, the tides are decidedly governed by the united solar and lunar forces. So at the Marquesas, although nearer to the Society Islands than any of those mentioned; but there the rise and fall is supposed not to exceed two feet. It is surprising that Mr Ellis, in his "Polynesian Researches," should have fallen into the same mistake, unless he means that the

Tahitian group comprises the whole of the South Sea Islands to which his remarks extend. In his observations on the tides, he says, " Among the natural phenomena of the South Sea Islands, the tide is one of the most singular, and presents as great an exception to the theory of Sir Isaac Newton as is to be met with in any part of the world. The rising and falling of the waters of the ocean appear, if influenced at all, to be so in a small degree only by the moon."

When others have contented themselves in merely giving their observations, without attempting to account for the diversity, I can hardly venture a single suggestion to solve the difficulty.

If Professor Whewell's Map of Co-Tidal Lines be correct, the tide travels, on the western coast of America, from north to south, between Acapulco and the Straits of Magellan; while, from the former, it travels northward and westward. The first, most likely, moves south, until it meets with the great tidal oscillation, which proceeds with great rapidity, in a westerly direction, round Cape Horn. There is, then, no difficulty in conceiving, that between these two great tidal waves, running in an ellipsis to the westward, the Society Islands are left in the intervening space, or what a Scotchman would call the "strath," unaffected by either of these waves, but still subject to the solar oscillation, which may form apart from that of the lunar. The tide-wave on the north will be inclined to the south, according to the moon's excursions in declination or southing; and this may account for the diversity at times, as already observed, of high-water being frequently an hour before or after noon, just as the base of the lunar wave may advance more or less to the south, by the moon's declination and parallax.

Peculiarities of tides, though of a different kind, are to be observed in many places. Professor Whewell mentions that about the Ower Shoal, the whole rise of the tide occurs in about three hours. In the Frith of Forth, it has been observed at times, that after the tide has begun to ebb, another rise takes place, though small in comparison with the first; so that, in fact, there are two larger and two smaller tides in the twenty-four hours.

It will be seen that, instead of the tides in the Pacific forming an exception to the Newtonian theories, they are quite in accordance with the principles laid down in the "Principia," and by Sir John Herschel in his "Treatise on Astronomy," sect. 530, where the relative disturbing forces of the sun and moon are about two and five feet. This comes pretty near to what is observed at Tahiti, in relation to other parts in the Pacific,—the tide at the Society Islands ranging from fifteen to eighteen inches, and at other groups from four feet six inches to five feet.

Before anything like correct information can be had on this interesting subject, a series of observations must be made at various points, by men who have time to devote to, and instruments proper for carrying on, the investigation. Now, as this ocean is likely to become, ere long, the highway between the vast continent of America and the British Colonies, every item of information connected with navigation should be sought after. I write not with the expectation that I can throw much light on the subject of the tides, but with the hope that others may be led to investigate it with the attention it deserves.

A Botanical Fact: an apt Illustration. Communicated by the Rev. Mr GILL.

A missionary on one of the Samoa islands, during a time of war, went to visit a part of the enemies' tribe in one of their strongholds. The tribe, with their chief, listened very attentively to the address given by the missionary. At its close the chief arose to reply. Profound silence prevailed; and with great politeness the old warrior addressed the missionary in the following terms:—

"We take it very kindly that you have been at so much trouble to come so far and so difficult a road to exhort us today. Many thanks to you for your kindness. We have listened with attention to your address; and all that you have said is true, especially that which you have said respecting our wickedness. We are indeed very bad,—we feel it to be so; and you have not said half that might be said respecting it."

Pausing a little, and looking round on the valley below, he said,—"You have now been living some time in our country, and in your travels you have often seen a *bread-fruit* tree withered, dying, all but dead, moss covering its trunk, no leaves on its branches, no fruit. You have thought,—alas! alas! this once fine tree is now only fit to be cut down and cast into the fire.

"A few months after you have returned that way, you have looked again on that bread-fruit tree; but now it is changed. The moss is clean off the trunk, the branches are all covered with green leaves, and they are laden with fine fruit. How changed! how beautiful! You look underneath, and there you see an '*aloe*.' When the bread-fruit tree had been found to be in a state of decay, the owner planted an aloe-plant near its roots, and in a very short time the influence of the aloe-plant checked the decay, and caused it to revive, to flourish, and to bring forth fruit.

"Now," said the warrior chief to the missionary, "while you have been speaking, I have been thinking we very much, just now, resemble the decaying, dying, worthless bread-fruit tree; but God has sent you with his Word, and he has planted you near to our side. Now, do not be soon discouraged,—do not fear. Very soon we shall revive,—we shall flourish and bring forth good fruit."

I have related this anecdote, to introduce to your notice the fact that an *aloe* planted near the withering bread-fruit tree causes it to revive. It is a beautiful fact, and, generally known, might lead some learned in botany to inquire into the causes, &c.

On the Explosion of a Meteor. Communicated by RICHARD CORBET, Esq., in a letter to R. CHAMBERS, Esq.

ADDERLEY, MARKET DRAYTON,
SHROPSHIRE, *March* 17, 1854.

MY DEAR SIR,—I send you a copy of a paragraph that appeared in the *Shrewsbury Journal* of the 15th instant, believing that it will not be uninteresting to you. The report of the explosion of this meteor was most *distinctly* heard by Mrs Corbet and several members of my family who were at the time in the flower-garden; they all exclaimed "Is that thunder? for there is not a cloud to be seen." Some pheasants in the plantation adjoining immediately made the same cry that they usually do in thunder. I should state that this house is distant at least 27 or 28 miles from the spot where the ball of fire is said to have exploded. At the same time the noise was heard here, one of my daughters was riding with her uncle, Sir Andrew Corbet, about half a mile from his house; on hearing it, he exclaimed, "Good heavens, my house is blown up." My brother's house, Acton Reynald, is at least 11 miles from the scene of the explosion. We were all at a loss to conjecture the cause of this peculiar report, till the following paragraph appeared in our Shrewsbury paper of Wednesday, March 15th:—

"On Ash-Wednesday a ball of fire visited us, and made such a noise amongst us, that your silence convinces me that you neither heard it nor heard of it, else you would have reported its report. Allow me, please, to give you this best account I can gather from the eye-witnesses. It was a beautiful, clear, mild day, and the sky was cloudless, when about half-past four in the afternoon, the ball of fire was seen moving, apparently about a yard above the ground, in a direction from west or east; it seemed to be eight or nine inches in diameter and to have a tail behind it. Between the Marsh and the Half-way House it burst, dividing, as the more credible of the witnesses says, into three pieces of unequal size; others speak of it as splitting into a thousand pieces. The noise of the explosion was tremendous, lasting over a minute, while the echoes continued nearly five minutes more. It was heard for miles round; many imagined it was an explosion of fire-damp in some of the neighbouring pits, when they found it was not followed by an earthquake. Of course the rustics are speculating what it portends; but as they cannot settle whether it came *out* of the earth or *to* the earth, they only agree in concluding we live in strange times, and strengthen this position by referring to the splendid aurora borealis seen here last Monday."

On the Uses of Industrial Exhibitions;—The Great Industrial Exhibition of 1853, *and its influence upon the Development of Industry in Ireland.* By Sir ROBERT KANE, F.R.S., M.R.I.A.

At this time, when the impressions produced upon our minds by the beauty and splendour of the Great Industrial Exhibition are still so vivid, and that its well-merited success forms still the subject of hearty and universal congratulation, as well for the character of our country, as for the liberality of the eminent individual to whom its arrangements were chiefly due, it may not be considered out of place that we should endeavour to lead the public to bestow some thought upon what the Exhibition really signified, and avail ourselves of the interest with which all connected with it is invested; to refer to the practical uses which may be derived from such industrial demonstrations, and in fact to recal the attention of the public from the mere fact of the Exhibition to the objects which the Exhibition was founded to effect.

For we have full reason to believe that a very large proportion of the visitors to the Exhibition were led by previous habits, or by the architectural and artistic illusions of the scene, to regard the Exhibition rather as a show than as a study—to look upon it not so much as a lesson as a lounge—to consider it decidedly better to have the military bands in the building than in the square, where they should go away if it rained—and to regard the examining of the objects as a concentrated form of shopping, without any implied necessity to buy. But none of these constituted the object for which the Exhibition was opened. The opening of the Great Exhibition of last summer had for its aim the demonstration of the great industrial force which Ireland could bring forward at this time, and its comparison with the industrial capabilities and results of the sister kingdom, and of foreign countries, thereby that we might see palpably and impartially manifested wherein we may fairly and indisputably claim pre-eminence or credit, where we were powerless or incapable, and that by careful and accurate comparison of our own position as to materials and means, as to skill and taste, we might learn wherein lay our weakness, and where our strength, and make ourselves ready to apply our industrial energies to those branches that might be found especially adapted to the country, and to ourselves, and avoid wasting our exertions on subjects in which nature denies us success.

The best and highest object of the Exhibition was thus one of a practical and national character. There was necessarily associated therewith the very important object of shewing to the public at large the great results of industrial invention, the triumphs of skill, and ingenuity, and taste—the highest points attained in ministering to material civilization in the several countries, which few can see, and which, even if seen isolatedly, cannot be appreciated, or their importance felt, as when aggregated in such a Grand Temple of Industry as the Exhibition formed. But naturally where the richest and most important manufactures of England, of France, of Germany, were displayed, the local element of the Exhibition became circumscribed, and to some extent overlaid, the more so as, from our industrial results being as yet but limited in variety and in extent, and also from a somewhat exaggerated spirit of hospitality, putting forward in all prominent places the productions of British and foreign contributors, rather than Irish works, the true amount and value of the products of our own country was not at first seen, and could not be fully appreciated by ordinary visitors. To those, however, who examined into the contents of the Exhibition with proper knowledge and care, the specially Irish portions, whether as raw materials or as finished productions, afforded satisfactory proof of the abundant means for industrial employment with which Providence has blessed our country, and of the capability of our people to carry out industrial pursuits, if properly directed.

It will be thus seen that we regard the object of the Exhibition to have been essentially that of instruction; and, in fact, we must consider all those accessories which distracted attention from that main and practical object to have been so far injurious to the proper object of the Exhibition. They were, of course, indispensable to its success and popularity under other points of view, and with the crowd, to whom purely instructional or useful objects are not congenial or attractive. Necessarily, also, in the classification and arrangement of such a gigantic aggregate of dissimilar things, hurriedly got together, and to be as hurriedly dispersed, the great condition of artistic grouping in effective masses predominated over the conditions of scientific arrangement; and the latter could only be observed as far as some general principles of distribution could be followed. This defect, inherent to the nature of so extensive and so temporary an undertaking (and even more evident in the London Exhibition of 1851), is capable of being avoided only where an Exhibition is organized for purely instructional purposes; where the objects exhibited are admitted only as they serve that view, and where the permanence of the collections admits of such methodical and progressive arrangements as shall enable, not merely the actual condition, but the advance, of every important branch of industry to be shewn. But precisely as in this manner the practical utility, as a means of instruction, of such an Exhibition would be enhanced, it might be feared that so would its popularity be diminished with the mass of the uninstructed general public. The gigantic proportions—the architectural paradoxes—the gorgeous effect—the suddenness of creation,—and the ephemeral existence, which rendered the visits to the Exhibition the social necessity and excitement of its day, being removed, it might be supposed, and with too much foundation, that the more solid but unpretending utilities that had formed the groundwork of so much splendour, would, when left to themselves, be unable to awaken curiosity or command attention.

It is, however, precisely in that point of view that we believe the results of the Great Exhibition to be likely to prove most useful. For the greatest difficulty previously had been to induce the general public to credit the necessity for instruction in industrial pursuits, to appreciate the vastness of industrial results, and to recognise the position due to the men who had placed themselves at the head of the industrial movement of the time. This difficulty will not, in future, be so insuperable. Even in England, so proud, and so justly proud, of her industrial power, it has been recognised that, to preserve or to regain her pre-eminence in many branches of trade, she must have artizans and employers of much higher and more cultivated intelligence than she now has, and that her educational means must be adapted in extent and character to the industrial wants of the present time. The real position of the industrial class in the State has also forced itself on the public mind in a very definite and positive manner; and the fact has become received that, by promoting and conducting great industrial undertakings, which diffuse comfort and contentment among the people—by fostering, in precept and example, the spirit of self-relying independence, of mutual charity and good will—one may render practical service to the State, and merit and obtain the highest and most public appreciation.

Thus the Great Exhibitions, by shewing to the public, in a palpable and unmistakable form, the grandeur and the complexity of industry, and by illustrating the amount of talent and knowledge necessary for its successful exercise, has paved the way for the organization of the means necessary for maintaining Great Britain in her proper place at the head of the World of Industry, and for even extending and perfecting in every direction the industrial forces which we now possess; and, as is usual, where a practical necessity is once felt, England is about meeting those exigencies in a great and proper manner; and there is very little doubt but that the steady and persevering energy which has enabled Great Britain to take the lead of Europe in so many practical matters, will enable her to become as successful in industrial education, now that she understands that she requires it as an instrument of practical success.

But all that has been said as to the necessity for education as an element of industrial success, and of the usefulness of exhibitions as a means of such education, applies even much more strongly to the circumstances of this country than of Great Britain. For in Great Britain, owing to the structure of its rocks, the coal and other materials for industry are diffused on so large a scale, and with such means for working, as to give it a natural supremacy in the most important branches of industry; and by the long-established habits and system, and the enormous capitals of the industrial classes, its natural advantages have been most effectively applied. Hence, in England, even under the disadvantage of the want of industrial education, great means of practical success exist, and will continue to exist; but in a country such as Ireland, where hitherto manufacturing industry has been developed only in one or two departments, and even those not generally diffused—where the public mind has not been specially fixed on industrial pursuits as the most desirable career for the middle classes—where the natural resources, although rich and abundant, are not so glaringly favourable, at least as regards coal, as in England—and where there exists no prestige of established success to command acceptance in the market—there evidently an advance in industrial character and pursuits can only be attained by means of a thorough appreciation and employment of all those points in which we can equal or excel our neighbours, and by an equally perfect acquaintance with those matters in which the circumstances either of the country or of ourselves forbid us to hope for any successful competition. Thus the industrial future of Ireland, at least, must depend on the knowledge which her people will acquire of the resources at her disposal, and of the means by which those resources can be made the most of. But for this is required an exact and scientific, as well as a practical knowledge of the condition and appliances of analogous departments of industry in other countries, and, consequently, a well organized system of industrial education.

The popular exhibition, standing thus to the true educational museum nearly in the same relation as a popular lecture in science stands to sound systematic teaching, has admirably served its purpose of exciting attention, stimulating curiosity, and directing public opinion; but these effects would soon die away, and the most valuable results be lost, if, in its several aspects, it were not followed up by arrangements of a more permanent character. In this it is to be hoped that the various institutions which we already possess in Ireland will heartily co-operate, and that each, in its separate field, will not merely continue, but redouble its exertions to promote the diffusion and enhance the character of industrial training in Ireland. For the great amount of good which may be done by our existing institutions will appear, to even a cursory survey of the portions of the general educational system already in action, disconnected and sometimes interfering, as they are, and therefore destitute of the harmony and energy of action which full administrative unity would produce.

The progress of industry in Ireland will be found specially facilitated by the admirable training which the young people of the labouring and artizan class are now receiving in the primary National Schools. This education, it must be recollected, is not by any means confined to reading, writing, and arithmetic, but embraces by the lesson-books, and otherwise, the elements of natural and physical science, general notions of political economy, and other subjects of practical interest, together with (in the higher schools) the elements of drawing, of agriculture, and (for females) of embroidery. To this nothing exists equal in Great Britain, and scarcely in Europe; and, moreover, in what are called the Model Schools, originally intended as model primary schools, but which have become really secondary schools of a very high class—as, for instance, in Clonmel,—the instruction given furnishes the sons of the middle class with the best and most practical education that can be had anywhere for a mercantile career, where the parents do not propose putting the boy through a complete University course.

The facilities for imparting industrial instruction do not, however, cease with the primary or model schools; special provisions have been made in the constitution of the Queen's University, and of the colleges belonging to it, for providing, in two very important departments, the means of instruction, and of verifying proficiency by University examinations and diplomas. So far as these professional courses are concerned, a means exists, which can be developed hereafter to any necessary extent; and the important principle has been conceded, that the branches of industrial education may properly take their place in a University course, and rank togegether with the older and more established orders of University degrees.

There is still another means of industrial education already in some degree existing among us, and which, although not special to this country, like the institutions of the National Schools and Queen's University, but only here as a part of the general arrangements for the United Kingdom, is yet so fully in the spirit of our local ideas, and so much in harmony with our general tastes and tendencies, that it should promise when well organised, to yield the most abundant and most profitable fruit. We refer to the means of education in industrial art—in design and decoration, in architecture, and finally, in all that range of subjects which extend from the purely intellectual conceptions of ideal art to the merely utilitarian construction of material. Few would be disposed to question the general diffusion among our people of an appreciation of artistic propriety—of taste in disposition of forms, and arrangement of colours, which is not so generally found in the sister kingdom; and we have every hope that, by means of the Schools of Design already in action, and by such further development in that branch as may be found expedient, our national capabilities may be rendered fully available for advancement in the various departments of industry, in which a large proportion of the value of the product depends upon the artistic excellence of its design, in construction or decoration, in form or colour. And if we run our eye over any catalogue of industrial objects, we shall find that, by this one department of education alone, a means of honourable and remunerative employment of a very high character would be opened to our artizan and middle class, to an almost unlimited extent.

In addition to those means of instruction which, extending through the country at large, and to be regarded, although collaterally, of great value for industrial objects, are so principally by their action on general education, and by, therefore, preparing the soil for more special and deeper cultivation, we have in the metropolis of Ireland also institutions which have borne excellent fruit, and have exercised no slight influence on the industrial position to which Ireland has already, even under so very many disadvantages, attained, and from which may be expected, in their several departments, even still more beneficial results. The industrial and artistic spirit which, paralyzed for so many years by the absorption of all public energy, and public attention, in the chaos of abstract political debate, had almost totally died out, was in a material degree preserved, and prepared for its invigorated revival, by the popular exhibitions which, from time to time, were held by the Royal Dublin Society. In the same institution also considerable energy has been displayed in the organization of a museum of agricultural objects, whilst the illustration of the natural sciences in the Museum of Natural History, and in the Botanic Garden (as well by its beauty as its associations, one of the chief ornaments of Dublin), has constituted perhaps the most popular and entertaining department of its labours.

To the Museum of Industry, founded by Her Majesty's Government in Dublin for special educational objects in all the various departments of industry, &c., and in which that permanent and legitimate exposition of industrial objects is to be carried out, which we referred to in the commencement as the indispensable corollary and sequel to popular exhibitions, we shall not here more particularly refer than to state, as we have done regarding our other educational establishments, the desirability of such development as will secure that the proper objects shall be efficiently carried out, and the imperative necessity for hearty and mutual co-operation on the part of every institution, and every person engaged in this great and beneficial work. And it is fortunate for the industrial and educational progress of the country that the public importance of the subject has made itself so sensibly felt, that a new department of the Government has been formed for the special administration of those branches of the public service under the Board of Trade. We may hence have every hope that whilst the unity and responsibilty of control indispensable in the management of institutions, supported either wholly or partially from the public funds, may be steadily maintained, there may be expected to result for the special institutions of all classes engaged in the work of industrial education more useful co-operation among themselves—a more sustained energy in their action, and greater efficiency and influence in their results, whereby will naturally result a more just and more general appreciation by the public of the actual excellencies of each, and a more certain recognition and reward to those who have been the agents of success, and who are entitled to the fair rewards of their honourable exertion.—(*Sullivan's Dublin Journal.*)

Notice of Two Additional Crania of the Ancient Short-horned Ox (*Bos longifrons*, Owen), *found some time ago near Newstead, Roxburghshire.* By JOHN ALEX. SMITH, M.D.* Communicated by the Author.

In a previous communication to the Society (April, 1851) I exhibited and described four more or less perfect crania of this ox, the *Bos longifrons*, which were found during the formation of a cutting on the Hawick branch of the North British Railway, in the vale of Melrose, a little to the east of the village of Newstead. They were discovered in a series of deep well-like shafts, which contained various remains, with Roman pottery and a few coins. Since that time I have been able to procure the two portions of skulls now before the Society, which, I believe, completes the collection of ancient animal remains that have been obtained from this place. The larger of the two skulls seems to have been an animal of rather greater size than any of those formerly described, measuring, as it does, about 7¼ inches across the forehead between the roots of the horn-cores ; and the horn-cores themselves are also larger, being 7¼ inches in circumference at the base. They are about 5¼ inches in length, but the points being broken, we cannot of course determine this measurement correctly. This skull is also more prominent in the upper part of the forehead, and has the "prominent edge standing up along the middle of the forehead," which Professor Nilsson of Lund gives as a specific character of this ox, more distinctly marked than in any of the other specimens. The second skull belongs to a much smaller animal, being nearly equal in size to the least of those formerly described. The measurements here are:—Breadth across the forehead between the horn-cores, 5½ inches. The horn-cores are nearly 3¾ inches in length, following the outer curvature; and their circumference at the base is 4 inches. In this individual also the prominence of the upper part of the forehead, and of the occipital ridge, is very distinct. These specimens are interesting, as shewing somewhat of the range in the size and shape of this animal. We may suppose the smaller to be a cow, and the larger one a bull. But in all the varieties of size there is a constant general resemblance in character. Professor Nilsson has described as a distinct species of ox, a variety principally distinguished from the *Bos longifrons*, by having longer pedicles to the horns, the forehead more rounded in front, and the ridge of the occiput rising high in the centre, which he has called the *Bos frontosus*; but you will observe that in the crania on the table, there is a very considerable variety both in the prominence of the forehead and the outline of the occipital ridge. In a letter with which I have been favoured by Professor Owen, he kindly informs me that two of the specimens previously exhibited are the most perfect crania of this ox which he has yet seen. And he considers that they tend to strengthen his opinion of the *Bos longifrons* being a distinct species of fossil ox; all the varieties which it presents in the different specimens he has examined, being within the limits of an admitted range; while he believes the *Bos frontosus* of Nilsson to be merely a variety of the *Bos longifrons*. This is the most ancient of the small sized cattle, being found in the drifts and fresh water deposits of the newer Pliocene formation, along with remains of the huge animals of that time, the elephant and the rhinoceros; and downwards through the deposits of the alluvium to the period of man, as the specimens on the table show, shortly after which it becomes lost as a species,—probably remaining in some of the domestic cattle as its later posterity; and as a small additional evidence on this point, I may mention, that in one of the skulls previously described,* there still remained three of the molar teeth; being the two last molars of the upper jaw, and the third, the last molar of the other side; these I have compared with the teeth of our domestic cattle, and found them to be almost identical in character, the arrangement of their enamel folds, and general structure being the same. I believe these to be the first remains of the *Bos longifrons* which have been discovered in Scotland. And I may also mention, that in May 1853 there was presented to the Museum of the Society of Antiquaries of Scotland, a portion of the lower jaw-bone of an ox, which had been found in a strange building, of several chambers, covered by a tumulus, and called a "Picts' House," situated on the western declivity of Wideford Hill, near Orkney, which was opened, and particularly examined by George Petrie, Esq. The specimen, which consists of a portion of the body of the jaw-bone, was lately examined, by Professor Quekett, of the Royal College of Surgeons, London, and was considered by him to belong to this same species of the *Bos longifrons*. It seems especially worthy of notice, as proving the existence of this small ox in the Orkney Islands, at a very early period, when the country in all probability was inhabited by some of the primitive races of our land; and is, as far as I am aware, the first instance of its existence being noticed so far to the north in Britain. I may remark, in conclusion, that the occurrence of this Orkney specimen, should we believe it to be a domesticated ox, is also interesting, as it may be considered an additional evidence of the early inhabitants of this country having tamed an original native breed, it being by no means likely that in this comparatively remote place the domesticated ox could have been derived from the cattle introduced, it may be, into the southern parts of Britain by the Roman colonist.

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* Read before the Royal Physical Society, Edinburgh, Jan. 25th, 1854.

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* *Vide* Plate ii., vol. liv. of Jameson's Journal.

Note.—Having, through the kindness of Professor Fleming, examined a skull of the small sized ox of the Shetland Islands, I have added some of its admeasurements for comparison with the smaller oxen referred to here, and in the previous communication (page 122, vol. liv., of this Journal). In this skull we have the prominent edge in the middle of the forehead, from the depression rising between and rather above the orbits, the rounded protuberance in the central part of the supra-occipital ridge. The horn-cores, however, are considerably longer and larger in proportion to the size of the skull, and curve backwards, outwards, and upwards.

Admeasurements of Skull of Shetland Ox.

	In.	Lin.
Length of skull from supra-occipital ridge, to front edge of intermaxillary bones, ...	17	3
Length from supra-occipital ridge along centre of forehead to nasal bones, ...	7	9
Length from roots of horn-cores to upper edge of orbits,	3	10
Length of orbits, ...	2	6
Breadth of orbits, ...	2	3
Length from orbit to end of maxillary bone, . .	7	8
Length from orbit to front edge of intermaxillary bone,	9	6
Breadth of forehead between middle of roots of horn-cores,	5	11
Breadth across narrowest part, ...	5	7
Breadth of skull across middle of orbits, ...	6	3
Breadth across front of intermaxillary bones, . .	2	11
Horn-cores, circumference of base, ...	6	4
Horn-cores, length following outer curvature, . .	6	6
Length of alveolar sockets of upper jaw, ...	5	6
Height of skull from supra-occipital ridge to upper edge of foramen magnum, ...	4	6
Height of skull from supra-occipital ridge to the base of the skull, ...	6	0
Breadth of occipital condyles, posteriorly, . .	3	10

Influence of Occupation upon Health.

A curious and interesting report has been prepared by Mr Finlaison, the actuary of the National Debt-office, upon the subject of sickness and mortality among the male members of friendly societies in England and Wales, as shewn by the returns made by them to the Government for the five years 1846–50. It appears that the proportion on the sick list in the course of a year is one in four, or 24·99 in every 100. The proportion seems large, but some allowance may have to be made for cases of feigned illness; and the persons in question are not those who are most favourably circumstanced in regard to food, clothing, lodging, and the various conditions of health. Mr Finlaison proceeds to divide the members of these societies into four classes:—1. Those who have heavy labour, with exposure to the weather—such as agricultural and other outdoor labourers—a class in which he has 353,103 cases; 2. Those who have heavy labour without exposure to the weather—such as smiths, sawyers, coopers, plumbers—a class numbering 94,259; 3. Those who have light labour, with exposure to the weather—such as shepherds, drovers, drivers, pedlars, messengers, custom-house officers—in number 58,809; 4. Those who have light labour without exposure to the weather—such as clerks, shopmen, barbers, factory operatives, servants—in number 286,909. He found that persons engaged in heavy labour, with and without exposure to the weather, have respectively 28·04 and 26·54 per cent. of their number sick in the year; persons engaged in light labour 20·80 and 21·58. In round numbers, taking a census of working-men disabled by illness, for every three whose work is light or moderate there are four of the class whose lot is heavy labour. The duration of sickness to each person sick is, however, upon an average, only 38 days and 40·73 in the two classes engaged in heavy labour, and 41 days and 44·25 in the two classes engaged in light labour. The mortality is heaviest among the persons classed as engaged in light labour; and indoor work shews itself less favourable to longevity than outdoor. But the main difference in the distribution of sickness seems to turn upon the expenditure of physical force.

"This is no new thing," says Mr Finlaison, "for in all ages the enervation and decrepitude of the bodily frame has been observed to follow a prodigal waste of the mental or corporeal energies; but it has been nowhere previously established upon recorded experience, that the *quantum* of sickness annually fallen to the lot of man is in direct proportion to the demands on his muscular power. So it would seem to be, however. Therefore, whatever scientific invention of machinery to save the expenditure of bodily strength may be devised, its production should be hailed as one of the greatest of blessings to the sons of toil, and not ignorantly contemned by the very class whom in reality it ultimately benefits. A study of the following digest leads to the conclusion, that the inventor of any engine which spares the physical energies diminishes the amount of human sickness in proportion as he, by means of his device, economizes the labour of his fellow-creatures."

The tables shew that the liability to sickness runs up to a temporary *maximum* in the young man, and then declines, and does not attain the same percentage until advanced years. This sick *maximum* of early manhood—the effect of a primitive demand on the bodily vigour—is in the period from 18 to 21, except in the class engaged in outdoor heavy labour, in which it appears to be at 14. The same percentage is reached, ever afterwards to increase, at the age of 48 in the class who have indoor heavy labour, 51 in the case of indoor light labour, 57 with outdoor heavy labour, and 65 with outdoor light labour.

These last remarks relate to the proportion of persons sick, not to the duration of the sickness. The duration of sickness does not decline in manhood, but increases with the age. The severity of the railway employment, according to these tables, tells upon the constitution; the men, it is said, get "weather-beaten." In the police there is a marked increase in the amount of sickness after 40, as if the service broke down the men at an earlier age than other occupations.

Important New Theories in Agricultural Science.

M. Baudrimont, professor of chemistry at the Faculty of Sciences at Bordeaux, has just published a work, "On the Existence of Interstitial Currents in Arable Soil, and the Influence which they can exert on Agriculture;" in which, after a long study of the subject, he states, that there is a natural process at work by which liquid currents rise to the surface from a certain depth in the ground, and thus bring up materials that help either to maintain its fertility, or to modify its character. Many phenomena of agriculture and of vegetation have at different times been observed; which, hitherto inexplicable, are readily explained on this theory. Such, for example, the improvement which takes place in fallows; and there is reason to believe that these currents materially influence the rotation of crops.

In Germany, Schleiden is attracting much attention by his masterly views on the phenomena of vegetation; and it will surprise many to hear that he admits of no relation between the fertility of a soil, and the quantity of fertilizing matter expended upon it.—"The goodness of the soil," he says, "depends upon its inorganic constituents—so far at least as they are soluble in water, or through continued action of carbonic acid; and the more abundant and various these solutions, the more fruitful is the ground." Arguing from this view, it is not richness of soil or humus that produces the multiplied varieties of alpine plants in Germany, or the absence of it that produces but few. "Soluble mineral constituents" are shewn to be the characteristic of our cultivated field; and "an agricultural plant" is defined as one, "distinguished from wild individuals of the same species, by peculiar qualities, which constitute its fitness in culture, and which depend upon a modification of chemical action." The amazing yield of Indian corn in Mexico—from 200 to 600 fold—is something which, with all our skill, we cannot accomplish, and is a fact in favour of the argument, "that in no case do the organic substances contained in the ground perform any direct part of the nutrition of plants." The annual destruction of organic matter all over the earth is estimated at 145 billions of pounds, equal to 2¼ billions of cubic feet; and if all vegetation depends on organic matter for nutrition, to satisfy this consumption, "there must have been, five thousand years back, ten feet deep of pure organic substance on its surface." Another illustration is furnished by taking the number of cattle and other animals in France in a given year (1844), and observing the amount of food they consume. The process of nutrition would require 76,789,000,000 pounds of organic matter—six times more than the whole number contribute of organic matter towards the reproduction; and in 100 years "the whole organic material of the country would be consumed!"

Again; look at a farm.—How much more is carried off from it than is given back again; generally the amount of its yield is three times greater than that of the organic matter it receives: while of the manure applied, the greater part is not taken up, but imperceptibly decomposed. Carbon is the most important of the constituents of plants. An acre of sugar plantation produces 7500 pounds of cane, of which 1200 pounds are carbon; and yet sugar plantations are rarely manured, and then only with the ashes of the burnt canes. With bananas, the result is still more striking:—the yield is 98,000 pounds of fruit in a year from a single acre; and of this 17,000 pounds—more than a fifth—is carbon; and the same acre will give the same return, year after year, for twenty or thirty years; and the ground at the end of that time will be richer than at the commencement, from nothing more than the decay of the leaves of the plant. Here in Europe, too, the difference in weight and in carbon between the seed and the produce has often been noted: in wheat, 89 per cent.; in red clover, 158 per cent.; in peas, 361 per cent. These facts afford evidence of a supply of carbon derived from other sources than those commonly supposed to exist; and while we know that seeds will germinate and become vigorous plants in pure quartzose sand, or in cotton wool, or on a board, we seem to have proof that the chief source of supply is the atmosphere. This is an interesting point, which further research will verify. Schleiden shews the process to be eminently simple. He says in his work: According to Link, Schwartz, and others, an acre of water meadow contains 4400 pounds of hay; which, when dry, contains 45·8 per cent. of carbon. The hay then yields 2000 pounds of carbon, to which 1000 pounds may be added in the portion of the year in which the grass is not cut, and the roots. To produce these 3000 pounds of carbon, 10,980 pounds of carbonic acid is requisite, which may be raised to 12,000 pounds to compensate for the nightly expiration. Now, Schubler has shewn, that an acre of so wretched a grass as *Poa annua*, exhales in 120 days (too low a computation) of active vegetation, 6,000,000 pounds of water. To supply the exigencies of the plants, therefore, it is only necessary for the meadow to imbibe 3½ grains of carbonic acid with every pound of water.

Mr Lawes has found also, that in a plant of any one of our ordinary crops, more than 200 grains of water must pass through it for a single grain of solid substance to accumulate within it. He states the evaporation from an acre of wheat, during the period of its growth, to be 114,860 gallons, or 73,510,000 gallons per square mile. With clover it is rather more; with peas and barley less. When we apply these calculations to a county or a kingdom, we are lost in the magnitude of the processes by which nature works, but we see the more clearly that on such a scale the quantity of material supplied by the air, though minute to the individual, becomes vast in the aggregate. We see, moreover, the necessity in understanding the relations between the evaporation and rate of growth, and the laws and effects of absorption in soils. A thousand pounds of dry calcareous sand will gain two pounds in weight in twelve hours, when the air is moist, while pure agricultural clay will gain thirty-seven pounds.

The source of nitrogen comes next to be considered: and this also is seen to be independent of manures. Hereupon it is observed, that "our domestic plants do not require a greater supply than in a state of nature. A water meadow which has never received any dung yields from forty to fifty pounds of nitrogen, while the best ploughed land yields only about thirty-one pounds. The plants for which most dung is used, as potatoes and turnips, are in fact proportionally the poorest in nitrogen." That there is a supply independent of the soil, is further seen in the millions of hides furnished every year by the cattle of the Pampas, without any diminution of produce; and in the great quantity of nitrogenous matters, hay, butter, and cheese, carried off from pasture land, far more than is returned by the animals fed thereon. Experiments with various kinds of plants, on various soils, have satisfactorily demonstrated that increase of nitrogen in the land and in the crop, does take place quite irrespective of supplies of manure.

With respect to ammonia, "it appears that one-thirteenth of a grain in every pound of water is sufficient for the exigencies of vegetation, and there is perhaps no spring water in the universe which contains so little." Then as to sulphur and phosphorus, which are also among the constituents of plants, the quantity needed in proportion to the time of vegetation is so small, that one 540,000th of a grain of sulphuretted hydrogen per cubic foot, diffused through the atmosphere to a height of 3000 feet is all that is required.

The consideration that cereals would soon disappear from the north of Europe, if not cultivated, and perhaps from nearly the whole of this quarter of the globe, adds weight to the arguments in favour of enlightened attention to the inorganic constituents of plants. The point is to bring the soil into harmony with the conditions by which growth may best be promoted. Much depends on the nature of the soil; the darkest coloured lands are generally the highest in temperature, hence the advantage of vegetable mould, while deep light sands and clay, which turn almost to stone in dry weather, weary and vex the cultivator by their unprofitableness. It is to be remembered, however, that soils which have the highest temperatures of their own, may not be those most susceptible of receiving heat,—that is from the sun, because some lands are warmed by the springs that irrigate them. Here we have an explanation of the phenomena of certain soils, which are warm in winter and cool in summer. The application of humus evolves heat by the process of combustion, and sand, lime, clay, and humus, are the combinations needed, the clay being in a proportion of from forty to fifty per cent.; if less than ten per cent. the land will be too light and poor.

Schleiden in summing up insists strongly on the necessity of selecting good seed; that from a barren soil, he observes, is likely to be more true to its kind than from well manured land. Also, that the time for sowing should be adapted to the acquirements of the plant, and it will surprise many to read that he advocates a less frequent use of the plough. He holds ploughing to be "a necessary evil, one to be employed only so far as necessity requires," because of the too frequent loosening of the soil, the decomposition of humus is so rapid as to overbalance the benefit supposed to arise from exposure to the atmosphere.

Such is a brief outline of some of the views of one who holds a high position among men of science; and though in some particulars they may seem to be at variance with practice in this country, there is much in them worthy the attention of intelligent cultivators.

An example to shew that the application of manure to fields might be more limited.

A few years ago, the Rev. S. Smith, of Lois Weedin, in the neighbourhood of Banbury, instituted a course of experiments on this very point, and with results which are singularly interesting. He took a field of four acres, having a gravelly soil, with clay, marl, and gravel as the subsoil. It had been hard worked for a hundred years; but except a thorough ploughing, no other means were taken to improve it, not a particle of manure was supplied. Wheat was then sown in single grains, three inches apart, and in rows a foot apart, a space of three feet being left quite bare between each three rows, and this was continued in alternate stripes all across the field. The sowing took place at the beginning of autumn; and in November, when the plant rows began to shaw, all the intervening three feet spaces were trenched by the spade, and six inches of the subsoil made to change places with the surface. "In the spring," says the reverend agriculturist, "I well hoed and hand-weeded the rows of wheat, and stirred the intervals with a one horse scarifier three or four times, up to the very period of flowering in June." The crop looked thin and miserable until after April, when it began "to mat and tiller," it did not turn yellow in May, and the stalk grew so stout and strong as to bear up well against the storm. When harvested, the result was highly gratifying, for the yield amounted to from thirty-six to forty bushels per acre, or rather per half acre, seeing that as the alternate strips were left bare, only one half of the field was really planted. The quantity of seed used per half acre was a little more than a peck.

Adjoining the field in which these experiments were carried on, was another which had four ploughings, ten tons of manure, six or seven times as much seed, and yet it gave quarter less to the acre.

This might be looked on as an accident, were it not that Mr Smith has repeated his experiments year after year, and always with greater success. He believes that if all the conditions be literally fulfilled, the same favourable result may invariably be obtained. No manure whatever is to be used; and in the second year, the strip is to be sown which was left bare in the first; and so on, changing from one to the other, year after year.—(*American Annual of Scientific Discoveries, for* 1854, p. 276.)

Classification of the Fossiliferous Rocks.

If the leading geologists of our country do not soon agree on a fixed nomenclature for the classification of the fossiliferous rocks, the cultivators and admirers of the science cannot fail to be misled, which will terminate in a great deal of false information being propagated. We want a classification that will apply to the whole globe—a classification arrived at by all the best judges, from physical, chemical, and palæontological geological facts; not a series of geological facts from any single geographical region, but a classification based on information from all the best described portions of our globe we are now in possession of.

While speaking on this subject we cannot overlook the controversy respecting the terms Cambrian and "lower Silurian," as it is still far from being settled; but we truly hope it will be so in a philosophic point at the next meeting of the British Association, by the most competent judges of the country. The journalist, who is undoubtedly guided by the best known and most correct information on the subject, is not in a position at present to give any decided information.

At the last meeting of the Association, three of our best geologists, Hopkins, Philips, and Strickland, agreed, and expressed a strong conviction, that Sedgwick would ultimately succeed in establishing his nomenclature; and on the other hand we have a party who think otherwise. It is not now the time to use either disguised or ambiguous phraseology. Let the question be determined on truth, and let truth only be the Polar star, and on this ground only let the combatants stand or fall. We can no longer be guided by the creed which certain parties assume in order to gratify the feelings or the prejudices of the party for which he caters to attract attention.

To shew how this disputed question now stands, I perhaps cannot do better than quote the opinion of Professor Jukes, President of the Geological Society of Dublin, on this subject. "I will just here say one word," remarks Mr Beete Jukes,* "as to the controversy respecting the terms 'Lower Silurian' and 'Cambrian.' It resolves itself into a question of whether we should take palæontological or lithological and stratigraphical characters as the foundation of our classification. Every one, including Professor Sedgwick and Sir Roderick Murchison, used to think that the rocks and fossils of Caernarvonshire and the neighbouring parts of North Wales, would of necessity be all older than those of Montgomeryshire, Shropshire, and the Welsh border country. The Silurian rocks and fossils, therefore, with their sub-division into upper and lower, were *accepted* as one thing, and the Cambrian rocks and fossils were *expected* to *turn out* another thing when the latter came to be fully described. Instead of that, it results that what were called the Lower Silurian rocks on the Welsh border, and which were left with a totally undefined base, had really a much greater thickness than was expected, and swept in many broad folds and undulations through the whole of North Wales, and that the rocks of Siluria, with the exception of the uppermost, were the same as those of Cambria. In Cambria, however, the rocks only were described, while in Siluria both the rocks and fossils were described and figured, neither, indeed, completely, but both so much so that the contemporaneous rocks of other countries could be recognised by their fossil characteristics. Had the identity of the rocks of Cambria and Siluria been known at the time, it is probable that only the upper would have been called

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* President of the Geological Society, and Director of the Geological Survey of Ireland.

Silurian and the lower would have been christened Cambrian. It was not so known or understood, however, and it has now, I believe, become practically impossible to remedy the mistake, if it be one, and to persuade men to call those things Cambrian which they have always been in the habit of calling Silurian, although *no one* will be more ready than *myself* to adopt the change of nomenclature, should it be generally decided on. The only way to bring such a correction into use would be to adopt a middle term, and to speak of the lower Silurian as *Cambro-Silurian.*

The following valuable Table of the divisions of the Fossiliferous Rocks will be found exceedingly useful for our geological readers.

Upper Stratified or Fossiliferous Rocks.

I. *Modern Rocks.*

Comprising all mineral accumulations of the present time, namely, Alluvial of the rivers, Coral islands and reefs, Thermal springs, Glacier moraines, Icebergs, Tide deposits, &c.

II. *Quaternary.*

Comprising the Diluvial rocks, the Drift and Erratic blocks, Cavern deposits and Osseous Breccias, Loess of the Rhine, &c.

III. *Tertiary.*

A. Upper Tertiary Group.	*Pliocene.* Crags of Suffolk, England.
	Antwerp Crag; Sands of Diest, Belgium.
	Cotentin Crag; Faluns de la Loire; Sables de la Sologne et des Landes, France.
	Oeningen deposit, Switzerland.
	Subapennine beds, or Mattajoue; Creta di Sienna, Italy.
	Aralo Caspian, or Steppe Limestone, Russia.
B. Middle Tertiary Group.	*Miocene.* Wanting in England.
	Bolderberg sands, Belgium.
	Calcare à Helix de la Beauce; Fontainebleau Sandstone;* Molasse de Leognan et Calcair de Bourg near Bordeaux; Sansan deposit; lower beds of la Limagne d'Auvergne; Gypse d'Aix, France.
	Nagelfluh and Molasse, of Switzerland.
	Molasse of Superga and Bormida's valley; Coal of Caddibuona, Piedmont.
	Salt deposits of Wieliczka, Poland.
C. Lower Tertiary Group.	*Eocene.* Barton Clay; Bagshot Sand; London Clay.
	Limburg beds; Brussels beds.
	Gypse de Montmartre; Grès de Beauchamp; Calcaire Grossier; Argile plastique de Paris; Molasse du Fronsadais et Calcaire de Blaye près de Bordeaux.
	Nummulitic formation. Dax, Biaritz and the Corbières deposits.
	Flysch of the Alps. Nummulitic Sandstone of Kressenberg, Austria.
	Ronca and Monte Bolca deposits, Vicentine. Macigno and Alberese of the Apennines.
	Kief and Antipofka rocks, Russia.

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* The Fontainbleau sandstone of Lyell belongs to the *Eocene.*

IV. *Secondary.*

A. CRETACEOUS GROUP.	A. Chalk of Maestricht and Valkenberg, Holland; Limestone of Faxoe, Denmark. B. White Chalk, or Chalk with flints, England; Craie de Meudon, France; Marly Chalk of Lusberg, Holland; Hippurite Limestone of Italy; Chalk of Kursk and of the country of the Don Cossacks. C. Lower Chalk, Chalk-marl and upper Grensand of England; Craie Tuffeau de France; Dieves and Tourtia of Hainaut, Belgium; Lower Chalk of Aix-la-Chapelle, Rhenish Prussia; white and red Scaglia of Italy; Carpathian Sandstone of Cracow and Orlova, Gallicia. D. Gault of England and France; Grey Scaglia, Italy; Quadersandstein of Saxony; Wienner Sandstein. E. Lower Greensand of England; Neocomian of Switzerland, France, Crimæa and Caucasus; Biancone of Italy.
B. JURASSIC GROUP.	A. Wealden. Weald Clay, Hastings Sand and Purbeck beds of England; Turtle Limestone of Soleure, Switzerland; Wealdens of Hanover and Westphalia. B. Upper Oolite. Portland beds, Kimmeridge Clay and Coral Rag of England; Portlandian, Kimmeridgian, Sequanian and Corallian formations of France and Switzerland; Solenhofen Schists and Nattheim Coral Schists, or White Jura of Swabia and Franconia; Majolica of Italy. C. Oxfordian. Oxford Clay, with Kelloways Rock, England; Argovian, Dives Clay and Kellovian of France and Switzerland; Spongites beds, Ornati Clay and Macrocephali bed of Swabia; Upper Alpine Limestone; Limestone of Porte de France of Grenoble, Dauphiné; Ammonitico Rosso of Italy; Moskwa beds of Russia. D. Lower Oolite. Cornbrash, Forest Marble, Bradford Clay, Bath Oolite, Fuller's Earth, Inferior Oolite of England; Vesulian Marls, Coral Limestone, Ladonian Limestone and Bayeux Oolite of France; Brown Jura of Swabia and Franconia. E. Lias. Whitby Shale, Lyme Regis Shale, Marlstone, Downcliff Sandy Marl, Aberthan Blue Marl and Linksfield Sandstone of England; Superliassic Grit, Vassy Cement bed, Middle Lias, Gryphæa arcuata Limestone of France and Switzerland; Jurensis Marl, Boll Schists, Balingen Clays, Arietes and Cardinia beds, or Black Jura of Swabia; Lower Alpine Limestone.
C. TRIAS GROUP.	A. Keuper. Yellow and White Sandstones, Grellfarbige Mergel, Schilfsanstein, Gyps and Mergel, Lettenkhole of Wurtemberg; Variegated Marls of England; Marnes Trisées of France; Verrucano of Italy.

C. TRIAS GROUP.	B. Muschelkalk. Hauptmuschelkalk, Salzgebirge, Wellenkalk, Wellendolomit of Wurtemberg; Calcaire de Lunéville, France; St Cassian beds, Tyrolese Alps; Limestone of Recoaro, Venetian Alps. C. Bunter Sandstein. Thonige and Kieselige Sandsteine, and Rothe Letten of Wurtemberg; Grès Bigarré of France; Upper New Red Sandstone of England.
D. PERMIAN GROUP.	A. Magnesian Limestone of England; Zechstein and Copper Schists of Thuringia; Upper Permian of Russia. B. Lower New Red Sandstone of England; Vosgian Sandstone of France; Todtliegendes of Germany; Lower Permian of Russia.

V. *Palæozoic.*

A. CARBONIFEROUS GROUP.	A. Coal Measures, Millstone grit of England; Terrian Houiller de France; Kohlengebirge of Germany; Goniatite grits of Russia. B. Carboniferous or Mountain Limestone of England; Terrian Anthracifère de la Sarthe, France; Bergkalk of Germany; Fusulina Limestone, Moscow Limestone, Lower Limestone of Tula and Kaluga, Russia.
B. DEVONIAN GROUP.	A. Upper Old Red Sandstone, or Petherwin Slate and Marwood Sandstone of Scotland and Wales; Grundt Limestone of the Hartz; Domanik Schiefer of Timans Mountains, Russia. B. Slate Rock and Limestone of South Devonshire, Plymouth Limestone, the Asterolepsis formation of Stromness, Caithness and Orkney Sandstone, England and Scotland; Bas-Boulonnais beds, Limestone of Sablé, France; Limestone of Sabero, Leon, in Spain; Limestone of the Eifel, Germany; Riga and Dorpat beds, Russia.
C. UPPER SILURIAN GROUP.	A. Upper Ludlow, Aymestry Limestone and Lower Ludlow of England; Flagstones and Tilestones of Steens fiord, Norway; Upper Limestone and Schists of Bohemia. B. Wenlock Limestone, Wenlock Shale and Woolhope Limestone of England; Coralline Limestone of Christiania; Isles of Gottland and Oesel in the Baltic; Schists and Red Sandstone of St Jean sur Erve, France; Middle and Lower Limestones of Bohemia.
D. LOWER SILURIAN GROUP.	A. Caradoc Sandstone of England; Graptolites Schists of Sweden and France; Pentamerus Limestone of Jelebeck, Norway. B. Landeilo and Bulith flags of England; Ardoise à Trilobites d'Angers, France; Etage des Quartzites of Bohemia; Pleta or Orthoceratites Limestone of Scandinavia and Russia. C. Bala beds, Tremadoc Slates and Lingula Flags of England; Drammen Flags and Sandstone of Christiania, Norway; Protozoic Green Schists of Bohemia; Ungulite Grit and Blue Shale of St Petersburg, Russia.*

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* Jules Marcou's Geological Map of the United States.

Cambrian of Sedgwick.

CAMBRIAN SERIES.	BALA GROUP.	Upper Bala, including Bala and Hirnant limestone, shales, flagstones, and conglomerates.
		Lower Bala.
	FESTINIOG GROUP.	Arenaig slates and porphyry.
		Tremadoc slates.
		Lingula flags.
	BANGOR GROUP.	Harlech grits.
		Llanberris slates.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *In Omenaks Fiord, known as Jacob's Bight, lies the famous Halibut fishing Station.*—Up this fiord, in the chasms of the trap, those enormous glaciers accumulate which have made Jacob's Bight, perhaps, the most remarkable locality in the *genesis* of icebergs on the face of the globe. It is not uncommon to have the shore here completely blocked in by these gigantic monsters; I myself counted one evening, the 3d July, no less than two hundred and forty icebergs of primary magnitude, from the deck of our vessel.

This remarkable station is worthy of the attention of all those individuals who take an interest in the fisheries.

2. *Are the floating Icebergs of the Polar Seas of the nature of nevé?*—I had incidentally met with the remark of Professor Forbes, that "the floating icebergs of the Polar Seas are in the most part of the nature of nevé;" and, while at a distance, I looked upon the substance of the mass before me as identical with the "firn," or consolidated snow of the Alpine glaciers, I now found cause, for the first time, to change this opinion. The ice of this berg, although opaque and vascular, was true glacier ice, having the fracture, lustre, and other external characters of a nearly homogeneous growth. The same authority, in speaking of these bergs, declares that "the occurrence of true ice is comparatively rare, and is greatly dreaded by ships." From this impression, which was undoubtedly derived from the appearance of a berg at a distance, I am also compelled to dissent. The iceberg is true ice, and is always dreaded by ships. Indeed, though modified by climate, and especially by the alternation of day and night, the Polar glacier must be regarded as strictly atmospheric in its increments, and not essentially differing from the glacier of the Alps.

The general colour of a berg, I have before compared to frosted silver. But when its fractures are very extensive, the exposed faces have a very brilliant lustre. Nothing can be more exquisite than a fresh, cleanly fractured berg surface. It reminded me of the recent cleavage of sulphate of strontian,—a resemblance more striking from the slightly lazulitic tinge of each.—(*The U. S. Grinnel expedition in search of Sir John Franklin.*)

3. *The Middle Ice, the position of the best known whale fishing-ground.*—The causes of this accumulation of ice, so disastrous to the navigation of the western and northern waters of the bay, may be attributed in some measure to the high latitudes leaving the ice as yet unaffected by the southerly and westerly influences to which I have alluded, and therefore more open to local causes of deviation, such as currents and winds.

It is through this ice-clogged bay that the great fleets of Baffin whale ships have, for the last twirty-two years, made an annual attempt to pass. The mysticeta, driven from their feeding-grounds on the coast of Greenland, have sought a refuge on the western side; and their seats of favourite resort in the early part of the season are now in the waters of Lancaster, Prince Regent, and Wellington Sounds, and the indentations of the north-western coast of Baffin's Bay. The vessels which have succeeded in penetrating this intervening ice-barrier before August are more of a full cargo, but after this time all efforts are useless. The "fleet" is spoken of as "baffled," and is obliged to seek other "grounds" to the south and west. It is, in fact, a great lottery, the caprices of the ice controlling the efforts of the most daring; and for the last two years or "seasons" before our arrival, the whalers had completely failed in effecting a passage.—(*Dr Elisha Kent Kane on the U. S. Grinnel Expedition in search of Sir John Franklin.*)

HYDROLOGY.

4. *Notice of the Discovery of a Deep Sea Bank in the Examination of the Gulf Stream.*—On the 11th of June, Lieut.-Commander Craven, having crossed the Gulf Stream without finding bottom at 1000 fathoms, came upon a sand bank at a depth of 469 fathoms, in lat. 28° 24′ N.; long. 79° 5′ W. It is supposed to be an extension of the Bahama Banks.

The following interesting remarks in regard to the nature of the bottom brought up, were made by Assistant L. F. Pourtales. M. Pourtales says,—"I have in hand specimens raised from the bottom of the Gulf Stream, obtained by Lieutenant Craven, and can say that they are the most interesting I have ever seen. You recollect that I said in my report that with the increase in depth (in the greater depths) the number of individuals appeared to increase. The greatest depth from which I had seen specimens was between 200 and 300 fathoms. There the sand contained perhaps 50 per cent.

of foraminiferæ (in bulk). The specimens now before me go to 1050 fathoms, and there is no longer sand containing foraminiferæ, but foraminiferæ containing little or no sand. The grains of sand have to be searched for carefully under the microscope to be noticed at all. The species are the same as found in the deep-sea sounding, but the specimens look fresher and appear somewhat larger. The *Globigerina* rosea of *D'Orbigny*, which forms the majority, has frequently that delicate pink colour to which it owes its name, but which I cannot recollect to have noticed in northern specimens. There are also some specimens of coral and dead shells from the depths of 1050 fathoms. The corals do not look much worn, but still appear to have been dead. There were some delicate living shells from depths beyond 500 fathoms."—(*American Annual of Scientific Discovery* for 1854, p. 309.)

5. *Artesian Well, Charleston, S. C.*—The following interesting table of the temperature of the Charleston well, at various depths, has been prepared by Professor Hume, of the State Military Academy.

		Degrees Fahr.
At the surface, the temperature of the water is—		68
50	feet the temperature is	68*
100	... .	68
200	... .	70
300	... .	71½
400	... .	72
500	... .	73½
600	... .	74½
700	... .	76½†
800	... .	80
900	... .	82½
1000	... .	84
1065	... .	86
1106	... .	88

From this table it will be seen that the increase of temperature by no means tallies with the increase of depth. The greatest increase of temperature seems to occur about those places at which streams of water were encountered, and the variations may be due to the fact that the well passed through some, as they descended from a higher and less heated, and through others as they descended from a lower and hotter level, and while the waters of both classes were still to some extent influenced by their previous temperature. The average rate of increase of temperature—1 degree F. for every fifty-two and a half feet—agrees with the results heretofore obtained in other wells.—(*American Annual of Scientific Discovery in* 1854, p. 300.)

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* At 58 eocene commences.

† At 708 cretaceous commences.

MINERALOGY.

6. ***M. Fuchs on Iron.***—M. Fuchs is of opinion that iron is a *dimorphous substance*, presenting itself under two distinct general forms or systems of crystallization, viz., the *tesseral* and the *rhombohedral* (or its modification, the *hexagonal*) ; and, consequently, there may be said to be two classification species of iron, which may be distinguished as tesseral and rhombohedral iron, and which are sometimes combined in different proportions. M. Fuchs' experiments have proved decisively, that the malleable or bar iron belongs to the tesseral crystallization form ; and it may be conjectured that all the malleable metals may be classed under that system of crystallization. The crystallization system of pig-iron is not so exactly determined ; but it is very likely that it belongs to the rhombohedral system, because facette iron, particularly, is one of the most brittle metals which generally belong to the rhombohedral form. The difference between bar and facette iron is based not only on the difference of the system of crystallization, but also in the great difference between their physical and chemical properties ; such as the tendency of the molecules of metal to burst and become displaced ; hardness, liability to oxidization, solubility, fusibility ;* and M. Fuchs is of opinion, that steel is an alloy of tesseral and rhombohedral iron ; and he thinks that hardening and tempering consists only in the transformation of all the molecules, or a portion of them, from one system of crystallization to the other,—the rhombohedral iron being predominant in hardened steel, and the tesseral in non-hardened steel.—(*Poggendorf's Annalen.*)

7. *Artificial Malachite.*—Rose of Berlin, by the following process, has succeeded in making artificial malachite, identical in composition with the natural green malachite. Precipitate a solution of sulphate of copper in the cold bicarbonate of soda or of potash ; allow the precipitate, which is voluminous at first, to çohere ; finally dry it, and wash it. By polishing, the characteristic appearance of malachite may be brought out.

GEOLOGY.

8. *On the Depth of the Primeval Seas, afforded by the Remains of Colour in Fossil Testacea.* By Edward Forbes, F.R.S., Pres. G. S. L.—When engaged in the investigation of the bathymetrical distribution of existing mollusks, the author found that not only the colour of their shells cease to be strongly marked at considerable depths, but also that well-defined patterns were, with very few and slight exceptions, presented only by testacea inhabiting the littoral, circumlittoral, and median zones. In the Mediterranean,

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* Wohler has already directed his attention to the fact, that every dimorphous substance has two different degrees of fusibility.

only one in eighteen of the shells taken from below 100 fathoms exhibited any markings of colour, and even the few that did so were questionable inhabitants of those depths. Between 35 and 55 fathoms, the proportion of marked to plain shells was rather less than one in three, and between the margin and two fathoms the striped or mottled species exceeded one-half of the total number.

In our own seas, the author observes that testacea taken from below 100 fathoms, even when they were individuals of species vividly striped or banded in shallower zones, are quite white or colourless. Between 60 and 80 fathoms, striping and banding are rarely presented by our shells, especially in the northern provinces; and from 50 fathoms shallow bands, colours, and patterns are well marked.

The relation of these arrangements of colour to the degrees of light penetrating the different zones of depth, is a subject well worthy of minute inquiry, and has not been investigated by natural philosophers.—(*Proceedings of the Royal Society, March* 23, 1854.)

9. *On the employment of water in filling up deep Bore-Holes in Blasting Operations.*—In working the great deposit of magnetic iron ore, which occurs, under peculiar circumstances, in the granite at Marovitza in the Banat, it has been found necessary, in consequence of the hardness of the rock and ore, to use bore-holes from 2 to 2¼ inches in diameter, and 36 to 40 inches deep. The packing of such holes with clay being a very tedious operation, Mr A. Keszt endeavoured to substitute water in the clay with considerable success. One of Brickford's safety fuses, which burns in water perfectly, is attached to the cartridge and fastened with the end; this cartridge is let down to the bottom of the hole, and about 1½ to 2 inches of clay firmly packed over it; the remainder of the bore, to nearly the top, being filled with water. In the case of very oblique bores, where the pressure of the water upon the bottom was small, he plugged up the orifice of the bore with a plug of wood driven with considerable force into it, through a slit in which the fuse passed. More recently still, he has used, instead of the small quantity of clay at first introduced to keep the cartridges from being wetted by the water, a mixture of tar and pitch, which most effectually preserves the powder from damp. Great numbers of trials have convinced him that the blasts fired with this arrangement loose nothing in force, whilst there is a very great saving of time and consequently of expense.—(*Oesten. Zeitschrift fur Berg-u-Hüttenwesen*, 1853. —*No.* 13.

10. *The American Tunnelling-Machine.*—Talbot's "tunnelling-machine" has been tried, with complete success; and it has been demonstrated that mountains of primitive stone, and the hardest rocks in the earth, can be successfully and economically tunnelled

by the agency of steam, applied to this new invention. The slow and expensive process of perforating by the drill and blast will be thrown aside. In the trial experiments the machine, moved by a steam-engine, cut an excavation of seventeen feet in diameter through the hardest rock at the rate of about three feet in two hours. The process consists in cutting and crushing the rock by means of rotating discs of steel, in successive series, which describe in their movement segments of circles from the centre to the circumference of the tunnel, with a gradual motion around the common centre; while the steam-engine is constantly pressing the machinery on a direct line with the axis of the tunnel. The newest and most extraordinary feature of the application of this power consists in the combination of different sets of discs, which act upon the entire surface to be excavated by a system of gradation perfectly regular, and by a power that is irresistible. The machine, which worked most satisfactorily, is made entirely of iron, and weighs about seventy-five tons, exclusive of the engine and boiler. One of the most interesting features of the experiment was when the machine began to cut the rock in an oblique direction, for it was observed that those discs or arms which were cutting the stone moved with the same facility that those did which were playing in the air. Gradually the cutters described their curve, the great faceplate of seventeen feet constantly revolved, throwing out and drawing back its arms with complete regularity, seizing and crushing the rock with irresistible power, Only four men are required to work this machine to the greatest advantage; and two of them confine their attention to the engine which propels it. There is no necessity for suspending the work day or night, except for those intervals when the cutters have to be sharpened, or new ones substituted. The amount of time and expense which is saved by the operation is almost incredible. This machine evidently supplies a want which has been felt in every department of civil engineering. It will revolutionise the whole system of railway construction, and is regarded as one of the most wonderful inventions of any age.

11. *Table of Statistics respecting the Mississippi, by Mr Brown.*

1. Quantity of water discharged by the Mississippi river annually, 14,883,360,636,880 cubic feet.

2. Quantity of sediment discharged by the Mississippi annually, 28,188,083,892 cubic feet.

3. Area of the Delta of the Mississippi, according to Mr Lyell, 13,000 square miles.

4. Depth of the Delta, according to Professor Riddell, 1,056.

5. The Delta, therefore, according to 3 and 4, as above, contains 400,378,429,440,000 cubic feet, or 2,720 cubic miles.

6. According to 2 it would require, for the formation of one cubic mile of Delta, five years and eighty-one days.

7. For the formation of one square mile of the depth of 1,056 feet, one year sixteen and one fifth days.

8. For the formation of the Delta, according to 2, 3, 4, time required, 14,208⅘ years.

9. The valley of the Mississippi, from Cape Girardeau to the Delta, is estimated to contain 16,000 square miles, of 150 feet depth; it therefore contains 66,908,160,000,000 cubic feet, or 454½ cubic miles.—(*American Annual of Scientific Discovery*, 1854, p. 306.)

12. *Age of our Planet.*—It is supposed that the plants of the coal period required a temperature of 22° Reaumur. The mean now is 8°, or 14° less.

By experiments on the rate of cooling of lavas and melted basalt, it is calculated that 9,000,000 of years are required in the earth to lose 14° Reaumur.

M. Hibert puts the period at 5,000,000. But supposing the whole to have been in a molten state, the time that must have elapsed in passing from a liquid to a solid state is fixed at 350,000,000 years.—(*Ami Boué.*)

13. *Use of Nitrate of Soda as a Fertilizer.*—The Royal (English) Agricultural Society having offered a prize for a manure equal to guano at a cost of £5 a ton, Mr Pusey has shewn that the conditions are satisfied by nitrate of soda, and at a charge less than that specified. He says in illustration, that 46 acres of land, if cropped with barley, and dressed with 17 cwt. of nitrate, would yield an increase of 80 sacks beyond the quantity usually obtained. A cargo of this fertilizer was brought to England in 1820, but for want of a purchaser was thrown overboard; a second importation took place in 1830; and from that date up to 1850, the quantity brought from Peru, where the supply is inexhaustible, was 239,860 tons, value £5,000,000. With the price reduced to £8 a ton—Mr Pusey observes—" Our farmers might obtain from their own farms the whole foreign supply of wheat without labour, and with but a few months' outlay of capital. I do not mean to say that no failures will yet occur before we obtain a complete mastery over this powerful substance; but I am confident so vast a resource of nitrogen—the main desideratum in the worn-out fields of Europe—cannot long be left within a few miles of the sea, passed almost in sight by our steamers, yet still nearly inaccessible, at the foot of the Andes."—(*American Annual of Scientific Discovery for* 1854, p. 281.)

BOTANY.

14. *Progress of Flax Cultivation in Ireland.*—The recent increase in the growth of flax in Ireland has been extraordinary, as the

following table, containing the number of acres under cultivation in each of the six last years, will shew :—

	Acres.		Acres.
1848 . .	53,863	1851 . .	138,619
1849 . .	60,314	1852 . .	137,008
1850 . .	91,040	1853 . .	175,495

There has thus been an increase of 29 per cent. last year over the crop of 1852 ; and 220 per cent. over that of 1848. The increase in the three provinces of Leinster, Munster, and Connaught, of the crop of 1853 over that of 1852, has been 22 per cent. ; and over that of 1848 no less than 436 per cent. ; the number of acres under cultivation in these provinces in 1848 being 2,663, and in 1853, 14,279. Notwithstanding this enormous increase in the production of home-grown flax, so rapid has been the development of the linen manufacture of these countries, that the imports of flax and tow amounted, in 1852, to 70,115 tons, or the produce of about 280,000 acres ; and during the nine months, ending the 5th Oct. 1853, the imports reached 62,264 tons, being an increase of 13,677 tons over the corresponding period of 1852.

Flax is becoming an article of export from Ireland, and the trade will, no doubt, rapidly increase if the cultivation of flax still further increase, as Irish flax seems to be sought after for certain purposes, not alone in England but on the Continent. Of the crop of 1852, there was exported 6696 tons of flax, and 2308 tons of tow—total 9004 ; value £392,500. Of this quantity, 413 tons were exported to France. The export in 1850 was only 3166 tons.

In 1852 there was 956 scutor mills, with 5053 stocks in operation, 50 being worked by steam. These mills employed about 15,000 persons, whose agregate wages may be estimated at £160,000. Forty of these mills, with 340 scutching stocks, were in the provinces of Leinster, Munster, and Connaught. During the year 1853 the number of mills has considerably increased, but no return has yet been made.

The Irish farmers are beginning to learn the value of saving the seed, as is shewn by the fact, that 20,000 bushels of seed were sold during the last year in Belfast alone to the oil mills, or for exportation to England—the sum realized being £5000. Three new oil mills, on continental principles, have been erected in Ireland in 1853, two of them being in the south of Ireland.—(*Journal of Industrial Progress*, No. i., p. 28.)

GEOGRAPHY.

15. *Augustus Petermann on the progress of the Expedition to Central Africa, by Messrs Richardson, Barth, Overweg, and Vogel, in the years* 1850, 1851, 1852, 1853.

On the results of the Expeditions generally.—The best and most correct idea of the results already gained by the expedition, will be found by comparing the maps of the present work with those published by their immediate predecessors, namely, those illustrating the travels of Denham and Clapperton. First, a large portion of Northern Africa and the Sahara, never before visited by Europeans, has now for the first time been thoroughly explored. The discoveries in the country of the Tuaricks, comprising the kingdom of Aïr in particular, form a considerable addition to our geographical knowledge of Africa. But the great achievments lie within Sudan, in the vast region between Guber and Mariadi in the West, and Dar For in the East, and ranging from the 15th parallel as far South as 5° north of the equator. The important discoveries of Denham and Clapperton, it must be borne in mind, were as yet confined to a region of which a great portion was known and mapped with some amount of truth before them, according to the information possessed by the Roman, Egyptian, and Arab geographers; whereas the whole region beyond the points reached by Denham, Clapperton, and Lander, presented a great blank—some vague indications only; as, for example, the existence of a country called Adamaua. Except Mandara, no pagan country to the south of Lake Tsad had ever been reached by any European before Barth and Overweg, and the merit of pioneering into these totally unknown regions belongs to them.

The actual extent of the routes accomplished by these travellers has been calculated from the present maps thus:—

	Geographical miles.	
Routes in Map of Northern Africa, . . .	1400	(as shewn by three sections).
	530	(not represented in the sections).
Do. in Map of Central Africa	3050	
Do. in General Map, not contained in the enlarged maps, ...	820	
	5800	

This only comprises the journeys of Dr Barth up to August 1852. The extent of the routes actually performed—viz., 5800 geographical miles—will be better appreciated when compared with other recent travels; as, for example, those of Galton in South Africa, the routes of which only amount to 1280 miles. The whole distance, in a direct line, from Tripoli to the Cape of Good Hope, is only 4080 miles.

But the mere linear extent of the routes of their explorations would convey an inadequate idea of the importance of their labours. It is the value of their astronomical, hypsometrical, and geological observations—the extent of their historical, philological, and ethnological researches—which, the writer confidently believes, will form a new era in the geography of the whole of Northern and Central Africa. And if the navigableness of the river discovered by Dr

Barth is such as is anticipated, a new era will also, it is hoped, dawn upon the regeneration of Tropical Africa, with its social questions—the questions of slavery and the introduction of Christian religion, civilisation, and commerce. The results of the long intercourse of the travellers with the ruling nations of that part of Africa—as the Tuaricks, the Fellatas, the Bornuese, as well as various pagan tribes—will enable the statesman and philanthropist to ascertain in what quarter and by what means this regeneration of Africa may be best wrought.

ZOOLOGY.

16. *On the Identity of Structure of Plants and Animals, by T. H. Huxley.*—Mr Huxley has ascertained that in all the animal tissues, the so-called nucleus (endoplast) is the homologue of the primordial utricle—with nucleus and contents—(endoplast)—of the plant, the other histological elements being invariably modifications of the periplastic substance. Upon this view, we find that all the discrepancies which had appeared to exist between the animal and vegetable structures disappear, and it becomes easy to trace the *absolute identity* of plan in the two,—the differences between them being produced merely by the nature and form of the deposits in, or modifications of, the periplastic substance. In both plants and animals there is but one histological element—the endoplast—which does nothing but grow and vegetatively repeat itself; the other element—the periplastic substance—being the subject of all the chemical and morphological metamorphoses in consequence of which specific tissues arise. The differences between the two kingdoms are mainly—1. That in the plant the endoplast grows, and, as the primordial utricle, attains a large comparative size; while, in the animal, the endoplast remains small, the principal bulk of its tissues being formed by the periplastic substance;—and, 2. In the nature of the chemical changes which take place in the periplastic substance in each case.

MISCELLANEOUS.

17. *On the Preservation of Buildings.*—We gave a short notice, in the last number of our Journal, of a process likely to be found useful for protecting many of our finer buildings from falling into decay, if taken advantage of; but how often do we find many of those highly important improvements in the arts entirely overlooked at the time they ought to be attended to, and only taken up when the process of destruction has gone so far as to be beyond reparation. We again call the attention of our readers to another important paper on this subject by the Rev. J. Barlow, M.A., F.R.S., Vice-President and Sec. R.I; and we hope that it will have some effect in rousing many of our dormant country gentlemen, military and civil autho-

rities, to a strict sense of duty, in so far as their charge lies in regard to the protection of castles, fine old mansions, cathedrals, churches, and universities. We cannot refrain from adding, that the *Terrace Building* of our *Own University* is already falling into rapid decay.

"Silica," says Mr Barlow, "is one of the most abundant substances known. Quartz, common sand, &c., flint, chalcedony, opal, &c., and a variety of sand described by Mr J. T. Way,* may respectively be taken as examples of crystallized and uncrystallized silica. Under all these forms silica is capable of combining with bases as an acid. Heat is, however, essentially necessary to effect this combination,—a combination of which all the well-known silicates, whether natural, as felspar, mica, clay, &c., or artificial, as glass, slags, &c., are the results. The common forms of insoluble glass are produced by the union of silica with more than one base. But, when combined with an alkaline base only, silica forms a soluble glass, the degree of solubility of which depends on the proportion which the silicic acid bears to this alkaline base . . . . . This soluble silicated alkali (or water-glass) may be prepared by various processes. If sand be used, 15 parts of fine sand, thoroughly incorporated with 8 parts of carbonate of soda, or with 10 of carbonate of potash, and 1 of charcoal fused in a furnace, will produce a silicated alkali which is soluble in boiling water. Messrs Ransomes obtained this silicated alkali by dissolving broken flints in a solution of caustic alkali at a temperature of 300° Fahr. And more recently, Mr Way has observed that the sand which he has described will combine with caustic alkali, at boiling heat, also producing a water-glass.

"This water-glass has been applied to several important purposes, three of which were specially noticed.

"1. *To protect Building-stones from decay.*—The stone surfaces of buildings, by being exposed to the action of the atmosphere, become liable to disintegration from various causes. Moisture is absorbed into their pores. The tendency of their particles to separate, in consequence of expansion and contraction, produced by alternation of temperature, is thus increased. Sulphurous acid is always present in the atmosphere of coal-burning cities, and cannot but corrode the calcareous and magnesian ingredients of oolites and dolomites. It is true that good stone resists these sources of injury for an indefinite time, but such a material is rarely obtained. As a preventive of destruction, whether arising from physical or chemical causes, it has been proposed to saturate the surfaces of the stones with a solution of the water-glass.

"It is well known that the affinity of silica for alkali is so feeble that it may be separated from this base by the weakest acids, even by carbonic acid. According to the expectation of those who recommend the silification of stone, the carbonic acid of the atmosphere will set the silica free from the water-glass, and the silica, thus separated, will be deposited within the pores and around the particles of the stone. The points of contact of these particles will thus be enlarged, and a sort of glazing of insoluble silica will be formed, sufficient to protect the stone against the effects of moisture, &c. This cause of protection applies chiefly to sandstones; but wherever carbonate of lime or carbonate of magnesia enters notably into the composition of the building stone, then an additional chemical action, also protective of the stone, is expected to take place between these carbonates and the water-glass. Kuhlmann remarks, 'Toutes les fois que l'on met en contact un sel insoluble avec la dissolution d'un sel dont l'acide peut former avec la base du sel insoluble un sel plus insoluble encore il y a échange; mais le plus souvent cet échange n'est que partiel.'[*] In consequence of this 'partial exchange,' an insoluble salt of lime may be looked for whenever a solution of water-glass is made to act on the carbonate of lime or carbonate of magnesia existing in oolitic or dolomitic building stones.

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* Quarterly Journal of Chemical Society, July 1, 1853, and Journal of Royal Agricultural Society, vol. xiv., part 1.

"This expectation, however, has not been altogether sanctioned by experiment. A gentleman, eminently conversant with building materials,[†] immersed a piece of Caen-stone in a solution of silicate of potash in the month of January 1849. This fragment, together with a portion of the block from which it had been separated, was placed on the roof of a building in order that it might be fully exposed to the action of atmosphere and climate. After five years the silicated and the unsilicated specimens were found to be both in the same condition, being both equally corroded. These specimens were exhibited in the theatre of the institution. But whatever ultimate results may ensue from this process, the immediate effects on the stone are remarkable. Two portions of Caen-stone were exhibited, one of which had been soaked in a solution of water-glass two months before. The surface of the unsilicated specimen was soft, readily abraded when brushed with water, and its calcareous ingredients dissolved in a weak solution of sulphurous acid. The silicated surface, on the other hand, was perceptibly hard, and resisted the action of water and of dilute acid when similarly applied."[‡]

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[*] Expériences Chimiques et Agronomiques, p. 120.

[†] Charles H. Smith, Esq., one of the authors of the "Report on the Selection of Stone for the Building of the New Houses of Parliament."

[‡] Silliman's American Journal, January 1854, contains a notice of the application of the water-glass to the decaying surfaces in the Cathedral of Nôtre Dame in Paris.

"2. Another proposed use of the water-glass is that of *hardening cements, mortar*, &c., so as to render them impermeable by water.

"Fourteen years since Anthon[*] of Prague proposed several applications of the water-glass. Among others he suggests the rendering mortars water-proof. He also suggests that this substance might be beneficially employed as a substitute for size in whitewashing and staining walls. It was demonstrated by several experiments, that carbonate of lime, mixed up with a weak solution of water-glass, and applied as a whitewash to surfaces, was not washed off by sponging with water, and that common whitewash, laid on in the usual manner with size, was rendered equally adhesive when washed over with water-glass.

"2. *The Stereochrome of* Fuchs.—The formation of an insoluble cement by means of the water-glass, whenever the carbonic acid of the atmosphere acts on this substance, or whenever it is brought in contact with a lime-salt, has been applied by Fuchs to a most important purpose. The stereochrome is essentially the process of fresco secco,[†] invested with the capability of receiving and perpetuating works of the highest artistic character, and which may be executed on a vast scale. Fuchs's method is as follows:[‡]—

"'Clean and washed quartz-sand is mixed with the smallest quantity of lime which will enable the plasterer to place it on the wall. The surface is then taken off with an iron scraper, in order to remove the layer formed in contact with the atmosphere; the wall being still moist during this operation. The wall is then allowed to dry; after drying it is just in the state in which it could be rubbed off by the finger. The wall has now to be *fixed*, *i. e.*, moistened with water-glass.[§] [An important point is not to use too much water-glass in moistening the wall.] This operation is usually performed with a brush. The wall must be left in such a condition as to be capable of receiving colours when afterwards painted on. If, as frequently happens, the wall has been too strongly fixed, the surface has to be removed with pumice and to be fixed again. Being

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[*] Neuere Mittheilungen über die Nutzanwendung des Wasser-Glases, 1840. This subject has been also fully treated by Kuhlmann in his "Mémoire sur l'Intervention de la potasse ou de la soude dans la formation des chaux hydrauliques," &c., 1841.—*Expériences Chimiques et Agronomiques.*

[†] *Vide* Eastlake's Materials for a History of Oil Painting, p. 142.

[‡] These particulars were obtained by Dr Hoffmann from Mr Echter. A stereochronic picture by Echter, and a sample of the water-glass as prepared in Munich, were also exhibited by Dr Hoffman.

[§] The composition of the specimen was—

	Per cent.
Silica	23·21
Soda	8·90
Potash	2 52

[The specific gravity of the solution 3·81.]

fixed in this manner, the wall is suffered to dry. Before the painter begins, he moistens the part on which he purposes to work with distilled water, squirted on by a syringe. He then paints; if he wishes to repaint any part, he moistens again. As soon as the picture is finished, it is syringed over with water-glass. After the wall is dry, the syringing is continued as long as a wet sponge can remove any of the colour. An efflorescence of carbonate of soda sometimes appears on the picture soon after its completion. This may either be removed by syringing with water, or may be left to the action of the atmosphere.'

"Not to dwell on the obvious advantages possessed by the stereochrome over the real fresco (such as its admitting of being retouched and its dispensing with joinings), it appears that damp and atmospheric influences, notoriously destructive of real fresco, do not injure pictures executed by this process.

"The following crucial experiment was made on one of these pictures:—It was suspended for twelve months in the open air, under the principal chimney of the New Museum at Berlin; 'during that time it was exposed to sunshine, mist, snow, and rain,' and nevertheless 'retained its full brilliancy of colour.'

"The stereochrome has been adopted on a grand scale by Kaulbach in decorating the interior of the great national edifice at Berlin already alluded to. These decorations are now in progress, and will consist of historical pictures (the dimensions of which are 21 feet in height and 24¾ in width, single colossal figures, friezes, arabesques, chiaro scuro, &c. On the effect of the three finished pictures, it has been remarked by one whose opinion is entitled to respect, that they have all the brilliancy and vigour of oil-paintings, while there is the absence of that dazzling confusion which new oil-paintings are apt to present, unless they are viewed in one direction, which the spectator has to seek for.

"Mr A. Church has suggested, that if the surface of oolitic stones (such as Caen-stone) is found to be protected by the process already described, it might be used, as a natural *intonaco*, to receive coloured designs, &c., for exterior decorations; the painting would then be cemented to the stone by the action of the water-glass.

"Mr Church has also executed designs of leaves on a sort of terra cotta, prepared from a variety of Way's silica rock, consisting of 75 parts clay and 25 of soluble silica. This surface, after being hardened by heat, is very well adapted for receiving colours in the first instance, and for retaining them after silication.

18. *On the relative values of different kinds of Meat as Food, by Marchal of Calvi.*—M. Marchal took 20 grammes of the muscles of the pig, ox, sheep, calf, and hen, which contained neither sinews or cellular tissue, or adhering fat, except what naturally exists between the muscular fibres, and dried them in a water bath for several

days, and thus ascertained the loss which each sustained by desication. The following are his results in 100 parts :—

	FIRST EXPERIMENT.		SECOND EXPERIMENT.	
	Solid Matter.	Water.	Solid Matter.	Water.
Pork, . .	29·45	70·55	30·25	69·75
Beef, . .	27·70	72·30	27·50	72·50
Wether Mutton,	26·55	73·45	26·35	73·65
Chicken, .	26·35	73·65	26·30	73·70
Veal, . .	26·00	74·00	25·55	74·45

According to these numbers we should arrange the meats in the following order of their relative nutritive powers :—pork, beef, mutton, chicken, veal. This order is, however, not the true one; because the leanest meat contains a certain amount of fat, and because this substance is not so important an article of food as the pure muscles, it is necessary to ascertain how much a certain quantity of meats contain before we can judge properly of its relative nutritive value. M. Marchal accordingly treated the dried flesh with ether to dissolve out the fat, and obtained the following results :—

	Fat soluble in ether.	Pure muscle insoluble in ether.
Beef, . .	2·54	24·95
Chicken, . .	1·40	24·87
Pork, . .	5·97	24·27
Mutton, . .	2·96	23·38
Veal, . .	2·87	22·67

The last table shews that the true order should be beef, chicken, pork, mutton, and veal, a result which experience confirms. It may, however, be remarked, that there is considerable difference between the same kind of meat derived from different animals; and that the same amount of two different kinds of beef broth, both containing the same amount of water, may have very different nutritive values. Further investigations are required upon this point.—(*Comptes rendus de l'Academie.—The Dublin Journal of Industrial Progress*, No. v., p. 156.)

19. A New Observatory has been erected at Vienna.

NEW PUBLICATIONS RECEIVED.

1. Recueil de 37 Itineraires dans la Turquie d' Europe, Details Geographiques, Topographiques, and Statistiques de cet Empire. Vienna, 1854. 1 vol. 8vo, of more than 600 pages. By Ami Boué.

A work thoroughly revised. It forms a necessary commentary to a new map by Kiepert, in 4 sheets. Many geographic desiderata are fully illustrated, as, for example, the structure of the large chains of the rhodope, the Potamography of North Albany, &c. It contains statistics not only of each Paschalik, but also of towns and even villages in many parts of that country. It is a work of great importance to military men, as in it they will find described the condition of the chief roads, the best military positions of the country, and the localities where an army would find provisions, and obtain hay in abundance.

2. Sur l'Establissement de bonnes Routes surtout de Chemins de fer dans la Turquie d'Europe. By M. Ami Boué. Vienna. 52 pp. in 8vo.

This pamphlet contains much important information on the means to be adopted to civilize rapidly the Empire.

3. The West Indies before and since Slave Emancipation; comprising the Windward and Leewards Islands, Military Command; founded on Notes and Observations collected during a Three Years' Residence. By John Davy, M.D., F.R.S., &c., Inspector-General of Army Hospitals. 8vo, pp. 551.

We have in this volume an admirable outline of the history of the West Indies. The talented author lays before us much interesting and valuable information on meteorology, geology, ethnology, agriculture, and political economy of the Windward and Leeward Islands—Barbadoes, St Vincent, the Grenadines, Grenada, Tobago, St Lucia, Trinidad, British Guiana, Antigua, Montserratt, St Christopher, Nevis, Dominica, West Indian towns; and an extremely important concluding chapter on the defects as to labour, education, sanitary measures, and the management of estates, &c. We recommend this work not only to all interested in our West Indian colony, but also to the general reader, as it contains much important and novel knowledge on natural science.

4. A Manual of Natural History for the Use of Travellers; being a description of the Families of the Animal and Vegetable Kingdoms; with remarks on the practical study of Geology and Meteorology. To which are appended Directions for Collecting and Preserving. By Arthur Adams, Esq., Dr Balfour, and Charles Barrow, Esq. 1 vol. 12mo, pp. 749. John Van Voorst, Paternoster Row, London, 1854.

This work contains much useful information, and has a valuable index, which is important to the student of natural history.

5. The Microscope and its Application to Clinical Medicine. By Lionel Beale, M.B., Lond., Professor of Physiology, &c. 12mo, pp. 303. Samuel Highley, Esq., 32 Fleet Street. London, 1854.

A work that ought to be in the hands of every medical student, and in the library of every medical practitioner. The information in it is excellent, and well arranged.

6. American Journal of Science and Arts. Conducted by Professors B. Silliman, B. Silliman junior, and James D. Dana, in connection with Professor Asa Gray of Cambridge, Professor Louis Agassiz of Cambridge, Dr Waldo J. Burnett of Boston, Dr Wolcott Gibbs of New York, has reached us up to March 1854.

7. Annalen der Physik und Chemie. Herausgegeben zu Berlin, von J. C. Poggendorff. Nos. 1, 2, and 4. 1854.

8. L'Institut. Journal Universel des Sciences et des Sociétés savantes en France et a L'Etranger, up to May 1854.

9. Memoires de la Société de Sciences Naturelles de Cherbourg, 1er Volume, 2 Livraison. Cherbourg.

10. Journal of the Geological Society of Dublin. Vol. vi., Part 1, 1853–54.

11. The Journal of the Royal Geographical Society; with Maps and Illustrations. Vol. xxiii. 1853. John Murray, Esq., Albemarle Street, London.

12. Jahresbericht über die Fortschritte der reinen, pharmaceutischen und technischen Chemie, Physik, Mineralogie und Geologie. Unter Mitwirkung von H. Buff, E. Dieffenbach, C. Ettling, F. Knapp, H. Will, F. Zamminer Herausgegeben. Von Justus Liebig und Hermann Kopp. Giessen, 1853.

13. The Quarterly Journal of the Chemical Society. No. xxv. April 1854.

14. The Quarterly Journal of Microscopical Science. No. 7. Samuel Highley, Esq., Fleet Street, London.

15. Journal of the Indian Archipelago and Eastern Asia. June–December 1853. Singapore.

16. Journal of the Asiatic Society of Bengal. No. vii. 1853. Calcutta.

17. The Cultivation of Tea in the district of Kangra. By W. Jameson, Esq., Director of the Botanical Gardens, N. W. P. Lahore, 1853.

18. The Journal of Industrial Progress. Edited by William K. Sullivan, Chemist to the Museum of Irish Industry. Dublin.

We have received six numbers of this monthly journal, and have perused them carefully, and found in each of them highly useful and practical information. It is a periodical that cannot fail to do much good in the country, and it will keep a lively energetic spirit afloat for practical science, which otherwise would not have been heard of.

19. The famous Prize Essay of Schabus, on Artificial Crystals, will appear shortly.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Biographical Notice of Marie-Henri Ducrotay de Blainville, de l'Academie des Sciences, Professeur Administrateur au Museum d'Histoire Naturelle, Professeur à la Faculté des Sciences de Paris; de la Societé Royale de Londres, &c. &c. By M. FLOURENS.

La Bruyère has said, that there is not in the world a more difficult task than that of making for oneself a name. He who spoke thus, supported by the attractions of criticism, dared to brave the difficulties he points out, and made for himself a very famous one. That individual of our associates, of whom I am this day to speak to you, had too much energy to be alarmed by a word of La Bruyère's; and, in his hard labours, what animated him was the pleasure of contradiction. He has succeeded, by obstinate efforts, in throwing a new light on some of the loftiest questions connected with the science of beings. He has tasted the success which criticism at all times obtains, and that species of warm admiration which opposition never fails to awaken, even when genius is the object of its attack.

Born at Arques, on the 17th February 1777, of Pierre Ducrotay and Catherine Pauger, M. de Blainville took pleasure in relating that, although his family was not among the most illustrious of the province, it yet went back as far as the 14th century; that he was the descendant of a Scottish gentleman, the rival of Sir Walter Scott's "Quentin," and who, possessed of nothing but his cap and sword, had received the name of Ducrotay from the place where he disembarked. After having thus placed the nobility of his ancestors under the ægis of Scottish loyalty, he added that, under Francis I., the government of the Château d'Arques, which was at that time rendered an important post from its position, was entrusted to one Robert Ducrotay; that the fortune of this family still increased under the descendants of the latter, who had the rare address to conciliate the favour of five successive monarchs, had been honoured with particular marks of esteem by Henry III., and received from Henry IV., who found in him an intrepid auxiliary at the battle of Arques, the confirmation of his titles of nobility, privileges, &c.

It was, therefore, in the bosom of a family proud of historical recollections and confident in its privileges, that the first moral impressions of the young Ducrotay de Blainville were formed. He was a younger son, and had the misfortune, at an early age, to lose his father. He received elementary instructions from the Curé, who resided near his paternal dwelling, and at a later period joined his eldest brother at the military school of Beaumont-en-Auge. The management of this school was in the hands of the Benedictine monks of Saint-Maur. One word is sufficient in its commendation; it had the honour to rank Laplace among its pupils.

The storm of the Revolution, by dispersing associations of ecclesiastics, too soon deprived young Blainville of this excellent means of instruction. He had scarcely reached his fifteenth year, when he was thrown back on the hands of a frail, oppressed mother, whose blind affection could oppose no sufficient barrier to a youth of a difficult temperament. All the value of a father's life, and the high importance of the experience of the head of a family who disguises none of the stern obligations of life from him who is to support the honour of his name, are often not appreciated till after a long series of disappointments.

At the age of nineteen, Henri de Blainville, desirous to push himself forward in the public service by his talents, spent some months at Rouen attending a school for drawing.

The manager of this establishment wrote to the mother of his pupil—"The character of the young man is rough; . . his heart, although not in a sound state, is not without good qualities; his greatest passion is a desire to learn; all the rest is a tissue of ill-combined ideas."

In order to complete his studies, M. de Blainville came to Paris. Scarcely had he arrived, when even the shadow of authority was removed from him, by the loss of his mother. Thus left to himself, his too great independence became to him a dangerous stumbling-block. He gave himself up to all the inclinations peculiar to his time of life; and, surrounded by thoughtless companions, he very speedily squandered in gaiety the whole of his patrimony.

Having thus arrived at the result to which this mode of life naturally led, he began to reflect, and perceived the necessity of replacing the means which could be no longer available for the future. In his first efforts, he did nothing but give vent to a restless activity. We find him by turns a poet and litterateur among his friends, and a zealous musician in the Conservatory; while in a celebrated studio we encounter him as a painter, and in particular a very skilful drawer.

Two lofty principles still survived in the heart of this young man; a high respect for his birth, and a thirst for knowledge. The former of these sentiments was not, indeed, without its attendant dangers; it gave rise to pretensions of a singular character. M. de Blainville had retained all the illusions of a gentleman of the previous century, to such a degree that he could never, even when become a sober-minded man, altogether divest himself of the assurance that he was provided, by royal appointment, with particular privileges. Of these the privilege of criticising and being always in the right seems to have been in his eyes the most valuable, and he made use of it constantly and everywhere; a circumstance which stood in the way of his intercourse with those who were unwilling to admit this obsolete feudality.

The desire of instruction, united to a pious regard for a family name, was the means of saving this stormy life, by holding out a noble object to unusual energy. When, on emerging from the last dreams of youthful folly, our fiery gentleman fell back upon himself, and found himself, at his twenty-eighth year, ruined, without profession, without family; if sorrow could not but oppress him, he was far from giving way to it; and making a solemn appeal to a stout heart and vigorous mind, he determined to rouse a degree of courage worthy of his ancestors.

It is only to a worthless Phrygian slave that one could succeed by exclaiming, "*Purchase your master*." Although of similar dispositions, M. de Blainville judged it prudent to accommodate himself to the manners of the age. Chance led him to a course of lectures on Natural Philosophy, delivered by M. Lefèvre-Gineau in the College of France; and here he was inspired with a hitherto unknown attraction, the love of serious pursuits. He was presented to the Professor as a modest neophyte, but he soon made himself to be so far appreciated as to gain admission to a house in which M. Gineau and his colleagues assembled, all of them connected with the higher departments of educational knowledge. It was in the midst of this circle of eminent men, that, for the first time, M. de Blainville found himself called to a congenial vocation. Nothing could harmonize better with his tastes and the tendency of his mind, than the authority of the chair, and the dogmatic tone of a master; the dominating influence which superior knowledge exercised over the minds of others, appeared to him the most enviable of distinctions; he conceived that he had discovered the path which was one day to lead him to reputation.

From that moment, continuous and ardent labour engrossed all his faculties. Yielding to judicious advice, he began by a profound analysis of human organization by means of important researches, and made such prodigious efforts and rapid progress, that after two years spent in the lecture-rooms and hospitals, he placed himself, by means of a remarkable work on Experimental and Comparative Physiology, in rivalship with Bichat, and took the title of doctor; leaving, struck with surprise, his noble compatriots, the gay companions of his early youth, who saw him, not without some feeling of regret, throw off the guise of the imprudent and frivolous votary of dissipation.

The rumour of this transformation one day reached his paternal dwelling, where the eldest of the Blainville's still resided. "Are you aware what your young brother has become?" a news-telling traveller said to him. "Nothing good, I suppose." "Know then that he is in the way of acquiring great renown." "Impossible!" exclaimed the feudal Norman, "he would never do anything."

The elevated character of his first works, his skill in seizing connections, his birth and singular beginnings, were all destined from the first to distinguish this new adept in science. While following in all its branches the course of instruction given in the Museum, M. de Blainville everywhere met with a generous sympathy. It was there—in this great and first school of modern Natural History—that during ten years of deep study, all the superior faculties were developed of a man who was to distinguish his progress by strength in meditation, and boldness and tenacity in controversy.

M. de Blainville first attached himself to Zoology. He has given to it a peculiar character. I particularly remark this distinct character in what he has left us on the Mollusca and Zoophytes. When he began to occupy himself with these two groups of beings, all the principal divisions were already established; the type defined, the classes formed, and these classes divided into orders; but the work relating to the genera still remained, a work which required singular sagacity, and in which M. de Blainville has excelled. He formed a conception of genera, as Linnæus conceived them. And this resemblance is not the only one I have found between him and that naturalist of such rare endowments. They are the only two systematists, perhaps, whose fire did not become extinguished among details. Linnæus gives to his details a living character by invented expressions. M. de Blainville animates them in a different way; he makes them the empassioned results of his preconceived ideas.

From Zoology, M. de Blainville passed rapidly to Comparative Anatomy. In these galleries, then in their infancy, every thing reminded him of the deep admiration he had felt, when, confounded in the crowd, he heard for the first time the eloquent voice of the great renovator, inspired with the ancient knowledge of Aristotle. But even this admiration awoke all his critical instincts, and already he had formed in his own mind the rash resolution of one day engaging in a contest with him.

While he dreamed of opposition and independence, the penetrating discernment of the man of genius had oftener than once rested upon him. Cuvier desired such proselytes to science; he sought for them, courted them, opened to them his library and his house, and did all this with a noble generosity, while they remained the satellites of his fame; but as soon as they became strong, and presumed to dispute the lion's part, the connection ceased. On one occasion, in the depth of a gallery, when M. de Blainville was absorbed in his contemplations, he saw Cuvier, the great Cuvier, then in the zenith of his brilliant career, coming up to him. "I have," he said to him, (whom he knew only by his works, and now spoke to him for the first time), "I have a proposal to make to you. Will you join your exertions to mine for the completion of a great work on Comparative Anatomy, with which I have been engaged for a long time? *You shall have a share in my reputation;* we will assist each other." Allured by the lively gratification experienced by a man of merit on feeling himself appreciated, and appreciated by a superior nature, M. de Blainville hastened to accept of this co-operation.

Placed forthwith in the first rank among the disciples, already celebrated, who devoted laborious exertions to the execution of works, the conception of which belonged only to their master, M. de Blainville, who could never endure the shadow of any kind of subordination, allowed the resentment of offended susceptibility to arise in his mind. He became fretful, complained with bitterness, and was listened to with kindness and gentleness; for much was to be pardoned in one who was of so much value. When the right of finding fault was conceded to him, the intractable pupil placed it on so broad a basis, that Cuvier said, with a smile, "Ask M. de Blainville's opinion on any thing whatever, or even say to him only *Good-day*, he will reply, No!"

Forced into a state of continual warfare, M. Cuvier still managed to derive advantage from it. He found in it the means of ascertaining all the assailable points of the ideas he promulgated; all were promptly attacked by this severe antagonist, who seemed, by disputing with this great man, to take upon himself the task of the ancient priests, repeating daily to kings in the midst of their power, *Forget not that you are men.*

In return for services so generously rendered, the master, judicious and skilful, neglected nothing to provide for the future comfort of his singular fellow-labourer. After having lectured for ten years in the Athenæum, he asked M. de Blainville to take his place. At a later period he entrusted him with the supply of his chair, first in the College of France, then in the Museum; finally, when the Faculty of Sciences required a Professor of Anatomy and Zoology, he surrounded his candidate in the competition with all the means of success. M. de Blainville was appointed, and thus acquired, with independence, an entire liberty of opposition, of which he made ample use.

He had not deceived himself as to his vocation. It is particularly by his teaching that M. de Blainville has given eclat to his scientific career. He possessed in the highest degree that easy fluency and animated turn of speech, as well as dictatorial tone, which subjugate and attract the minds of an audience. To the judicious composure which scatters cautiously the germs of fruitful knowledge, he preferred the bold forms of an elevated logic. He succeeded in inflaming young heads who would not otherwise, without some resentment, have manifested marks of warm sympathy with a disciple who sought his own elevation by contradicting a great master. And this master was still Cuvier notwithstanding, for whom the youth were so full of enthusiasm, but in whom they attempted indirectly to blame the philosopher for being forgetful of a praiseworthy and independent simplicity.

Such success was not calculated to set their intercourse on a more agreeable footing. After a sojourn of some months in England, M. de Blainville returned rich in scientific matter. Still believing his just supremacy to be respected, Cuvier asked him to communicate it to him. The traveller merely replied, "In order that it may be at your disposal more readily, I am about to publish it."

Urged on by a restive disposition, in a manner contrary to the feeling of fidelity which at heart he seriously entertained, M. de Blainville allowed himself to go the length of breaking off altogether under frivolous pretexts.

M. Cuvier regretted his loss of the important aid of a high and rare intelligence; but he was well aware that the advantages of contradiction would not be wanting to him. As to M. de Blainville, he deprived himself of an incalculable advantage, in the loss of intimate intercourse with a superior mind, replenished with all the qualities calculated to moderate and direct—sound reason, calm and enlightened thought, and that prevailing *good sense*, which is the real master and final judge of every thing in this world.

In every vicissitude of life, the energetic individual whose character I am considering seems to have found a new strength in labour. He astonished his contemporaries by the vigour with which he prosecuted his studies. Profound researches, bold discussions, deep historical synopsis, nothing could wear out the resources of this ardent and versatile spirit.

In 1822, he published the first volume of a general treatise on Comparative Anatomy. With this work appeared a new doctrine.

M. Cuvier had improved Comparative Anatomy by the experimental method, which proceeds from facts to ideas. All M. de Blainville's efforts, and all his works, were directed to an opposite method.

His first care is to form an abstract type of a living being. Buffon had said: "We may distinguish two parts in the animal economy, the first of which acts perpetually without any interruption, and the second acts only by intervals. The action of the heart and lungs appears to belong to the former; the action of the senses, and the movement of the body and limbs, to the latter."

This view became, with Bichat, the principle of his famous distinction of the two lives—*organic life* and *animal life.*

Buffon had added: "Let us invest the interior part in a suitable envelope, that is to say, let us give to it senses and members, animal life will soon manifest itself; and the more fully the envelope shall contain the senses, members, and other exterior parts, the more complete will the animal life appear, and the more perfect will be the animal."

M. de Blainville combines these two ideas of Buffon. There is in life, two lives—the life of nutrition and the life of sensation.

Buffon saw nothing in the general envelope but the exterior part, the seat of the sensations. M. de Blainville regards this envelope as continued, becoming folded, penetrating into the interior, and becoming the seat of the respiratory and digestive systems.

Lastly, just as there are two lives, there are likewise two great kinds of apparatus—the vascular and the nervous—and on these two apparatus all the organs depend; on the first, the organs of sense and motion; on the second, the organs of secretion and nutrition.

The abstract type of a living being once settled, it affords to M. de Blainville a new frame-work where all the details of Comparative Anatomy, almost infinite in number, become classified and concentrated. The various structures seem nothing more than realised instances of a previous conception. The dogmatic process is substituted for the experimental, and M. de Blainville may likewise call himself a master and a great one, for he has transfused into the science the complexion of his mind and his own peculiar originality.

So many and such laborious efforts had for a long while secured a place for M. de Blainville in the Academy. He was admitted in 1825. In 1830, a royal ordinance having divided the educational duties of the Museum of Natural History devoted to the illustration of the invertebrate animals, M. de Blainville was naturally chosen, in consequence of his beautiful works on the Mollusca and Zoophytes, to occupy one of the two chairs.

Thus, although he was late in devoting himself to the sciences, he obtained the most favourable position they could bestow, and he saw accomplished the destiny he had traced out for himself, when he told Cuvier, in one of his spites against him, "I shall one day have a chair in the Institute and Museum of Natural History, by the side of you, in front of you, and in spite of you."

In spite of you was unjust, for animosity did not exist; but it would have diminished his gratification if he had ceased to believe in it; only experience had proved to M. Cuvier the difficulty of intercourse with him, and made him doubt the practicability of it.

M. de Blainville had reached that age when a man of superior mind feels the need of uniting his ideas together by a philosophical bond of connection.

His long-continued studies in Zoology had led him to perceive in the whole animal kingdom only a *continuous series* of beings which, becoming with each degree more animated, more sensible, more intelligent, rise from animals of the lowest grade up to man himself. This grand view was that of Aristotle in ancient times, and it has been that of Leibnitz in modern days.

"*The continuity of gradations*," Aristotle finely remarks, "covers the limits which separate beings, and withdraws from the eye the point which divides them."

"I love maxims which support themselves," said Leibnitz. We know that in order to obtain such he had thought of bringing them all to one. His philosophy has only one principle, that of continuity. Each being in the globe we inhabit is connected with all others, and the globe itself with all other globes. "With M. Leibnitz," said Fontenelle, "one should have seen the extremity or end of things, or that they have no end."

Never has a philosophical idea undergone greater vicissitudes than that of *the scale of beings*. All the naturalists of the eighteenth century admit it. "The progress of nature takes place by insensible degrees," Buffon tells us. "Nature makes no sudden leaps," exclaims Linnæus. Bonnet exhausts himself in simple efforts to discover everywhere intermediate, equivocal beings, which should fill up the voids.

Cuvier appeared, and the entire idea of continuity or sequence is at once set aside. The animal kingdom is divided into determinate, circumscribed groups, widely separated, without connection, without intermediate links.

To M. Cuvier succeeds M. de Blainville; and with him we again restore the *series of beings*, but, this time at least, more developed, more complete, approaching more nearly to being everywhere demonstrated; and, what is the last stage of advancement in this department, essentially connected with the doctrine of final causes, a doctrine every day becoming better understood and more respected.

This chain of associated beings, adapting themselves to each other, visibly implies a determinate design, a plan followed, an end foreseen.

Final causes are the highest philosophical expression of our sciences, and the most moderate.

There is a pleasure of a superior order in discovering and contemplating this wonderful assemblage of so many diverse *ressorts* combined in such just proportions. The spectacle of an Infinite Wisdom imparts tranquillity to the human mind, "It is not a small matter," said Leibnitz, "to be content with God and the universe."

In 1832, science received a terrible blow; Cuvier was carried off in a few days.

The managers of the Museum thought it their duty to transfer M. de Blainville to the chair in which the modern Aristotle had immortalized himself.

From this time forward, in the character of a vigilant and almost jealous guardian, M. de Blainville pitched his tent beside the collections, purchased by half a century of enlightened labour. A tent indeed it might be called—an abode worthy of our philosophers of the Middle Ages—where he reproduced both their lengthened meditations and inexhaustible enthusiasm.

Spending his life in a gloomy cabinet, and entrenching himself there in the depth of a vast easy-chair, surrounded by a triple rampart formed by a confused assemblage of books, original drawings, anatomical preparations, and ill-secured microscopes, if at any time a studious pupil was admitted, he had more than one obstacle to surmount in order to introduce himself; for the confusion was general, and if it was difficult to find a seat, it was not less so to find a place for it. At last, after the good fortune of getting installed, if, in the ardour of study, a volume required to be sought for, it was usually necessary to draw it from the base of a mountain whose general overthrow amounted, in this chaos, to a real cataclysm, which, considering that it was so frequent, was not on that account attended with less confusion.

If an adventurous visitor, after a long parley, reached the inviolable asylum, while still upon the threshold, and without any movement indicating that his presence had been observed, a grave and sonorous voice was heard with the invariable question, "*What is there here for your use, sir?*" Sometimes the stranger, on the first appearance of things, became disconcerted, not supposing that there could be an itinerary for such a labyrinth as he saw before him, or not having sufficiently foreseen how painful it is for a deep thinker to have the course of his ideas deranged. In such a case he had to seek for safety in a quick retreat, and thereby excuse his imprudence. If, on the contrary, the first words that escaped the disturber announced a person worthy of a learned conversation, M. de Blainville immediately raising his head, and divesting himself of the thoughts that occupied him, employed all the advantages which his ready eloquence put at the service of great knowledge to delight his auditor. If the latter, pleased with his courtesy, prolonged his visit, he exposed himself after his departure to the risk of eliciting from the laborious savant the exclamation, "*Again another hour lost!*"

But was it an old pupil that came to receive knowledge from his master? He might confidently surmount every obstacle—the kindest reception awaited him; for if M. de Blainville, as a true gentleman, required his pupils to render him complete *faith and homage*, it was with sincere and almost paternal affection that he regarded them in return.

It was from this sanctuary of study, that, after having been a long time enclosed, as poets tell us Minerva was in the brain of Jupiter, afterwards emerged in complete armour that ardent controversy respecting all the arguments on which Cuvier founded the new science of Palæontology.

The first germ of this surprising science of *lost beings* is to be found in an old belief—that of a great ancient deluge.

In vain scholastic philosophy pretends that fossil shells were nothing more than *freaks of nature, jeux de la nature.* In vain the philosopher Voltaire, who, for reasons anything but philosophical, would not on any account that there had been a deluge, multiplies the number of pilgrims to explain the dispersion of marine shells; neither freaks of nature nor pilgrims could answer the purpose. Supported by evidence of the fact, and by unextinguishable tradition, the common sense of men protested against such explanations.

In the seventeenth century, the attention which had been excited by fossil shells, was directed to the gigantic bones preserved in the bowels of the earth, whose first origin was equally concealed.

In 1696, some bones of an elephant were discovered in the principality of Gotha. The Grand-Duke immediately assembled the council of learned men; the council unanimously declared that they were *jeux de la nature.*

About the same time some of the bones of the animal we now call the Mastodon, were found in Dauphiné, one of our own provinces.

A surgeon of that country bought these bones, and had them conveyed to Paris, where he exhibited them for money, affirming in a pamphlet, that they were taken from a tomb 30 feet long, and that they were the remains of a giant, king of one of the barbarous people who were defeated near the Rhone by Marius. All Paris was anxious to see this trophy of Marius' glory; and, according to their almost invariable practice, after believing at first all that was told them, they soon sneered at all they had believed.

The eighteenth century at last brought on the serious study of such objects. Gmelin and Pallas make us acquainted with the fossil bones of Siberia; they inform us that such bones are found there in prodigious abundance, some of them being those of a Rhinoceros, others belonging to an elephant, and gigantic ruminants.

Who shall be the fortunate interpreter of these strange facts?

Gmelin and Pallas think that an immense irruption of the sea, coming from the south-east, could alone transport these huge remains, all belonging to southern animals, into the northern lands.

Inspired by a loftier genius, Buffon, now almost an octogenarian, conceived the idea of extinct species.

" The bones preserved in the bosom of the earth," he says, " are proofs as authentic as they are unexceptionable, which demonstrate to us the past existence of colossal species different from all those now existing."

" It is with regret," he adds with eloquent emotion ; " it is with regret that I leave these precious monuments of a former world, which my advanced age denies me time to examine. This investigation of beings which have disappeared, would of itself require more time than I have to live, and I can only recommend it to posterity ; others will come after me."

This prophecy has been fulfilled. To the glory of our own age, Cuvier has created a new art ; he touches these scattered relics, and revives to our astonished view the extinct races. He examines every stratum of the globe, and each gives up to him its peculiar population.

He first finds the crustacea, mollusca, and fishes ; then reptiles ; next mammifera, but mammifera of a race no longer existing ; he finds the races now living only at the actual surface of the globe.

Life, then, is developed only gradually, progressively ; and the beautiful theory of the *succession of beings* grows and rises like the most certain deduction from the best established observations.

There have been, according to Cuvier, many partial and successive creations ; these multiplied populations became perfected, while they became diversified ; and we must suppose violent and sudden causes to account for the rapid disappearance of so many species at once.

M. de Blainville takes up each of these propositions, one after another, and combats them all.

He contends for a single and simultaneous creation—a first and complete population, subject to incessant extinctions; and he requires only slow and ordinary causes to account for these repeated destructions.

What! he exclaims, you pretend that at each revolution you suppose, the Great Artificer of created things recommenced his work!

But remark, in the first place, the general resemblance which connects living with lost species. In spite of all your skill, you have not been able to distinguish, by a certain feature, the fossil elephant from the existing elephant of the Indies.

You yourselves admit that, among fossil animals, many are to be found which differ in nothing from living animals.

The facts on which you found your theory are therefore insufficient and incomplete facts. Incomplete facts cannot be set as a limit to our conjectures.

In the absence of complete facts, which he was no more possessed of than Cuvier, M. de Blainville sought for a superior reason which might in his estimation occupy their place, and free his impatient mind from the annoyance of waiting. This superior reason appeared to him to be found in the *unity of the kingdom.* And here science is indebted to him for one of its great steps in advance.

As long as he confined himself to the study of existing species, the animal series presented to him everywhere lacunæ and voids. In every quarter beings were wanting. It was then that, with the glance of genius, he saw and recognised in lost Nature the beings which were wanting in living Nature, and that he intercalated with surprising address the fossil species among the existing species, seizing from that moment, and being the first among all naturalists to disclose to us at last, the unity of the kingdom.

The animal kingdom is therefore one,—the unity of the kingdom seems be to the first demonstrated point of the *unity of the creation.*

After having explained the contrary opinions of the two authors, I proceed to examine their systems, which are not less so.

M. Cuvier follows facts, alike determined both to wait for them, however slowly they appear, and to accept the result which they yield, whatever that may be, whether the theory of successive creations, if the species continue and are found everywhere separate and superimposed; or the theory of a unique and simultaneous creation, if he at last finds them in some degree united and confounded.

M. de Blainville takes a great fact, which he transforms into a principle; the fact, the unity of the kingdom; and from the unity of the kingdom he boldly infers the unity of the creation.

It is always, on the one hand, the experimental method, with its process sure, and its results uncertain; it is always, on the other, the dogmatic method, with its results presented as certain, but obtained by a process which is not sure.

The human mind makes use of these methods, and judges them. It has this excellent quality, that it never finds rest except in the full and entire knowledge of things. It is this restlessness for truth—the continuous movement of a divine impulse—which forms its strength in labour, and its delight in discovery. In the new study in which we are engaged, a multitude of facts—I mean necessary facts—is still wanting to us. We have explored only a part of the globe's surface; there are places where, in so important an inquiry, nature is surprised at not having been examined. It will raise up bold observers, who will lay open unknown regions. It will raise up new thinkers. The beautiful science of the Cuviers and de Blainvilles—for these two names are united by the very opposition of their ideas—has brought us at last to this important point, of fixing with precision the problem which divides it; and this problem of the successive or simultaneous order of created beings, is assuredly the greatest which the genius of man has ever conceived in the domain of natural history.

Ideas so exalted and full of allurement having obtained the ascendency in his mind, M. de Blainville became less and less disposed to condescend to that confiding intercourse of friendship which renders life smooth. To excuse himself for this to his own mind, he attributed to the rigour of principle what was nothing else than an error of judgment.

He was then in possession of the *privileges*, sufficiently real, which attended success. This did not lessen his pretensions. He brought them with him into this Academy, in spite of the warning which Fontenelle has given us,—"Here we desire that all should be simple, that no one should believe himself pre-engaged to be in the right; that no system should predominate, but that the avenues to truth should always remain open."

This liberty of being in the right (*d'avoir raison*), of which he had too well learnt to exercise the entire powers in his professorship, appeared intolerable when it applied to him in his individual capacity. In replying with such decisive authority, M. de Blainville forgot that he had descended from his chair, and that in this place all the seats were equal. "Undoubtedly," said one of his associates, the judicious historian whom I have quoted, "undoubtedly the investigation of truth requires, in the Academy, the liberty of contradiction; but every society requires a certain degree of respect to be observed in contradiction, and he did not remember that the Academy is a society. We did not fail to be sufficiently aware of his merits in spite of his manners; but some degree of equity was necessary, and it is always better that men should be spared."

These attempts at justice were only exerted by M. de Blainville, to enlighten and rouse to a sense of duty those around him, and to inspire his versatile but inactive colleagues and academicians. Henceforth, adopting an extreme resolution, he seemed to say to himself—

> Mon dessein
> Est de rompre en visière à tout le genre humain.

He deserted our assemblies; and, like a new Alcestes, to find—

> Sur la terre un endroit écarté
> Ou d'être homme d'honneur on eût la liberté,

he barricaded himself more securely in the recesses of his cabinet.

M. de Blainville had undertaken to give, in a great work on *Comparative osteography*, a description of the collections entrusted to his care, and he superintended, with that severity of attention which was peculiar to him, the drawings made with that view, which no one could judge of better than himself. This undertaking was attended with enormous expense, and had every claim to the encouragement which public authority has always granted to great and important publications. It was a matter of simple justice, therefore, that this work should be placed under the patronage of government. But in order to obtain it, it was necessary to ask for it, and make these claims understood, and never was there a misanthrope less disposed to set aside the prerogatives of his bad humour.

Estimating very highly, and with just reason, the value of the author and of the work, M. de Blainville alleged that they should come to him, and beg of him to accept of this aid; for, in addition to the fearful hatred he had vowed against the human race, he treated everything like authority with a higher degree of irritation, as it hurt his feelings as a gentleman; and he never could be prevailed on to condescend to make the demand in question. He suffered and complained bitterly, and gave himself all the satisfaction that could arise from accusing everybody; his colleagues, the Academy, Institute, the minister, government, all were to blame, except himself. He never abated in his stubbornness, and thereby deprived himself of the possibility of completing his immense and learned catalogue.

This same individual, whose jealous hauteur was roused at the very appearance of receiving a favour from those in power, and whose previous history assuredly did not display him in the light of a pacificator, was however occupied, about this period, with a subject embracing the most delicate views of conciliation.

Under the title of *History of the Sciences of Organization, taken as a Basis of Philosophy*, he gave to the public, in 1845, a work whose object he describes as being the union of philosophy and religion.

Always carried away by preconceived views, he proceeds in the same manner in history as he did in science. He *forms types*. Aristotle is the type of the natural sciences in ancient times, Alfred the Great in the middle ages, and M. de Lamarck in our own days. He overlooks nearly all other naturalists; and, in his prejudiced representations, he does not sufficiently recollect that history is a judge, and that the first duty of a judge is impartiality.

Not less presumptuous as a diplomatist than as a historian, he claims the first ranks of philosophy for Lamarck, Gall, and Broussais, whom he calls the great philosophers of our age. Under such imperfect guidance, he ventures into uncertain paths, and avoids the only one that is sure—that, namely, which Bossuet has followed in his immortal treatise *On the Knowledge of God and of One's self.*

It is in vain to persist in this object, and a mere loss of time. The science of organization can never be the basis of philosophy; the domains are separate and distinct. What we now call philosophy, and what Descartes by a more precise term denominated metaphysics, has only one object, strictly circumscribed, namely, the study of the mind.

As a rational means of appreciating the progress of the human mind in the natural sciences, it is worthy of being remembered that M. de Blainville's book had been preceded by one from Cuvier on the same subject—the slowly matured production of a calmer intellect.

On comparing this work with the former, we involuntarily call to mind the famous verse—

> "Mon flegme est philosophe autant que votre bile."

A great interval separates the penetrating mind which discovers what is weak in the ideas of others, and the reflecting mind which judges its own thoughts. Too impatient to submit his theories to a severe analysis, but too prudent to leave them exposed to attacks which might be attended with danger, M. de Blainville had recourse to stratagem; he carried the war into the territories of his rivals, and forced them always to remain on the defensive by allowing them neither peace nor truce.

The desire of success, that implacable tyrant, made him by turns the stubborn contradictor, and the attractive and fascinating professor; and in the latter capacity success was certain. When taking upon him the part of an instructor, he not only displayed all his intellectual advantages, but he likewise permitted all his good moral qualities to appear. The trust of being useful, the hope of being loved, the attraction of gratitude, removed at such a time all the asperities of his outer man. The feeling of predominance was sufficient to make obstinancy and pretension disappear; and confiding in his audience, and disguising none of his efforts, he gained much by being seen in this light.

One day, on coming from one of his lectures, an old pupil came up to congratulate him on the successful manner in which he had treated a great question. "I am glad you are satisfied," M. de Blainville said to him; "the subject was difficult, and for eight days I have meditated on this lecture from nine o'clock in the morning till midnight."

This confession discovers a very severe conscience; for never did any one possess in greater perfection the gift of brilliant improvisation. He has been often known, after a rich and impassioned lecture of an hour and a half, if but a little excited by some objection, to recommence again with closed doors, and, recovering immediately all his resources, continue arguing with all his might, yielding nothing, and always remaining the last champion in the field.

Such keenness in dispute subjected the friendships he had formed to singular trials, and assuredly they never were in danger of becoming stagnant in a dead flat. "During nearly half a century," we are told by a faithful companion, the wise Pylades of this hot-headed Orestes, "during nearly half a century that our intimacy lasted, it was rather sustained and cemented by discussion than by a perfect agreement."

In fact, if M. de Blainville gained the cause too easily in behalf of the proposition he supported, he immediately took in hand the opposite one. At last it came to be exclaimed with impatience, What is really your opinion? is it *yes?*—No, it is not *yes.* It is then *no?* I have proved to you that it could not be no. It must be one or the other; say which, "*O! ho!*" he then exclaimed, "*Do you forget then that I am a Norman?*" Everything in him, both physical and moral, recalled this origin.

He was of medium stature, but of remarkable vigour. His eye, lively and penetrating, indicated a superior intelligence. The simplicity of his exterior left us to infer his confidence in a personal value which would owe nothing to honorary distinctions—distinctions to which he had proved his entire indifference. No vain show or petty vanity lessened this man. It seemed as if he had said to himself that by study alone his life could be sufficiently distinguished. However, under all its coverings, the heart was always in its right place; and even when it appeared impenetrable, if it did vibrate, its emotions were only the more lively.

Having become proprietor of the small seignorial domain of his ancestors, M. de Blainville went every year to look upon its plains and hills, to breathe the invigorating sea air, and invite the breeze which had cradled his early years to evoke pleasing recollections. During the time he occupied his small manor-house, the savant disappeared, and the gentleman was not a grumbler. Those who courted his society in his country-house were received with perfect amiability, which reminded them at once of the advantages of birth and superior acquirements; and he displayed in society, especially in that of ladies, a real coquetry of mind and agreeable manners, which threw back into the distant horizon, and among the mists of science, everything that savoured of the misanthropical.

This pleasure, arising from recollections, found another aliment in the assembling of representatives of all the epochs of M. de Blainville's life. Frequently meeting in his house, this circle of friends opened their ranks to all the philosophies, to the most opposite opinions, to all social positions, and to all ages; for the severe critic and profound thinker could not disguise his regard for the youngest among them. In return for so sincere an affection, an entire devotedness now consecrates the pious cares of filial regard to his illustrious memory.

In the beginning of the year 1850, M. de Blainville thought himself obliged, notwithstanding the alteration in his health, to open his course to the Faculty of Sciences. He reappeared in his first lectures with an ability which had lost *nothing either of* its strength or lustre.

Oppressed, however, by gloomy presentiments, on the evening of the 1st of May he left his modest mansion in the Museum, saying that he would very soon return; he only wished, he said, to breathe his native air, and look again upon the spring and sunshine lightening the beautiful plains of Normandy.

This wish was not accomplished. Scarcely had he taken his place in the waggon that was to convey him, when he was suddenly seized with illness, and this great man was no more. The authority which watches over the humblest citizens could alone guard his last moments, and restore to his friends and colleagues the mortal remains of a man so worthy of respect, and by whom the nothingness of life had never been forgotten.

Extraordinary Fishes from California, constituting a new Family. Described by L. AGASSIZ, Professor of Zoology and Geology in the Lawrence Scientific School at Cambridge, Massachusetts.

About fifteen months ago, I received a letter from A. C. Jackson, Esq., soon after his return from San Francisco, California, informing me that while fishing in San Salita Bay, he had caught with a hook and line, a fish of the perch family, *containing living young.* The statement seemed so extraordinary, that though an outline of the specimen observed was enclosed, I suspected some mistake, and requested Mr Jackson to furnish me further information upon what he had actually seen, and if possible specimens of the fish preserved in alcohol. To this inquiry, I received the following answer:—

"I regret much that the information which I sent you avails so little, without the actual specimens of the fish and young; these, however, I have already taken active measures to obtain, and trust before many months to be able to send you at least specimens of the female, if not of the young. I should at the time I caught the fish have preserved them in alcohol, but at *that time I* was attached to the Navy Yard Commission, and was with my comrades industriously prosecuting the examination of the vicinity of San Salita, as to its adaptiveness for a navy yard, and could not leave for San Francisco without suspending the work; and the means for preserving the fish could not be otherwise procured. This explains the apparent culpable indifference which allowed me to omit preserving the specimens. I have sent directions to California to have caught for me several of the fish; and if at the present time (September 16th, 1852) the females were pregnant (which is not probable) to take from one the bag containing the young, and put mother and young in the jar of alcohol, and put several other females untouched into a jar also. These specimens will by direction and examination, even if they be not pregnant, and if the jar contains no young, determine the truth and accuracy of the statement I made in my former letter on the subject. This fact proved by these specimens, it will be very easy to obtain during the next spring and summer specimens in all stages of pregnancy. I think if I remain in the country, I can assure you a sufficiency of specimens, to determine to your satisfaction the true state of the affair, during the course of the next year. The fish I refer to, in my opinion, does not exist in very great numbers even in the waters of San Salita Bay, for the two which I caught on this occasion were the only ones which I fell in with, though I fished in the same place probably four times. There was a little peculiarity perhaps in the circumstance of my taking them as I did. I had previous to this time tried my rod and line, and as I mentioned before, four times, always with success as regards groupers, perch, &c., without a sight of the singular fish under consideraton. A few days, perhaps a week, after the four trials, and on the *7th of June*, I rose early in the morning for the purpose of taking a mess of fish for breakfast, pulled to the usual place, baited with crabs, and commenced fishing, the wind blowing too strong for profitable angling; nevertheless on the first and second casts, I fastened the two fishes, male and female, that I write about, and such were their liveliness and strength, that they endangered my slight trout rod. I however succeeded in bagging both, though in half an hour's subsequent work I got not even a nibble from either this or any other species of fish. I determined to change the bait, to put upon my hook a portion of the fish already caught, and cut for that purpose into the largest of the two fish caught. I intended to take a piece from the thin part of the belly, when what was my surprise to see coming from the opening thus made *a small live fish.* This I at first supposed to be prey which this fish had swallowed; but on further opening the fish, I was vastly astonished to find next to the back of the fish and slightly attached to it, *a long very light violet bag, so clear and so transparent, that I could already distinguish through it the shape, colour, and formation of a multitude of small fish (all fac-similes of each other) with which it was well filled.* I took it on board (we were occupying a small vessel which we had purchased for surveying purposes); when I opened the bag, I took therefrom *eighteen* more of the young fish, precisely like in size, shape, and colour, the first I had accidently extracted. *The mother was very large round her centre, and of a very dark brown colour, approaching about the back and on the fins a black colour, and a remarkably vigorous fish.* The young which I took from her were in shape, save as to rotundity, perfect miniatures of the mother, formed like her, and of the same general proportions, except that the old one was (probably owing to her pregnancy) much broader and wider between the top of the dorsal and the ventral fins, in proportion to her length than the young were. *As to colour, they were in all respects like the mother, though the shades were many degrees lighter.* Indeed, they were in all respects like their mother and like each other, the same peculiar mouth, the same position and shape of the fins, and the same eyes and gills; and there cannot remain in the mind of any one who sees the fish in the same state that I did, a single doubt that these young were the offspring of the fish from whose body I took them, and *that this species of fish gives birth to her young alive and perfectly formed, and adapted to seeking its own livelihood in the water. The number of young in the bag was nineteen,* (I fear I misstated the number in my former letter), *and every one as brisk and lively, and as much at home in a bucket of salt* *water, as if they had been for months accustomed to the water.* The male fish that was caught was not quite so large as the female, either in length or in circumference, and altogether a more slim fish. I think we may reasonably expect to receive the specimens by the first of December. But I can hardly hope to get satisfactory specimens of the fish as I found it with young well grown, before the return of the same season, viz., June. By that time I trust the facts will be fully decided, and the results, as important as they may be, fully appreciated."

In a subsequent letter, (dated January 31, 1853), Mr Jackson informed me that he had requested Capt. Case, U. S. N., who commanded a sloop of war in San Francisco, and who had also seen the fish, to supply my friend T. G. Cary junr., Esq., of San Francisco, with specimens of that fish, should he succeed in getting any. I wrote myself also to Mr Cary, to be on the look-out for this fish.

About a fortnight ago, I was informed by Mr Cary, in a letter dated San Francisco, August 10, 1853, that after a search of several months he had at last succeeded in obtaining several specimens of this remarkable fish, three of which were sent by express (which have reached me lately), while a larger supply was shipped round Cape Horn. After a careful examination of the specimens, I have satisfied myself of the complete accuracy of every statement contained in Mr Jackson's letter of February 1852, and I have since had the pleasure of ascertaining that there are two very distinct species of this remarkable type of fishes, among the specimens forwarded to me by Mr Cary. I propose for them the generic name of *Embiotoca*, in allusion to its very peculiar mode of reproduction.

I feel some hesitation in assigning a family name to this type. It is probable that all its members will present the same peculiarity in their mode of reproduction, and that, therefore, the name *Embiotoca* may with perfect propriety be modified into *Embiotocoidæ,* as Didelphis has given its name to a numerous family, the *Didelphyidæ,* after having been for a long time simply a generic name. Should it, however, be found that other types of this family present various modifications in their viviparous reproduction, for which the name *Embiotocoidæ* might be objectionable, I would propose to frame some family name from another structural peculiarity of these fishes, not yet observed in any others, the naked furrow-like space parallel to the base of the posterior dorsal fin, separating the scales which cover the base of the rays from those of the sides of the body, and name it *Holconoti*.

The perseverance and attention with which Messrs Jackson and Cary have for a considerable length of time been watching every opportunity to obtain the necessary materials for a scientific examination of these wonderful fishes, has induced me to commemorate the service they have thus rendered to zoology, by inscribing with their names the two species now in my hands, and which may be seen in my museum in Cambridge, labelled *Emb. Jacksoni* and *Emb. Caryi*.

A country which furnishes such novelties in our days, bids fair to enrich science with many other unexpected facts, and what is emphatically true of California, is in some measure equally true of all our waters. This ought to stimulate to renewed exertions not only our naturalists, but all the lovers of nature and of science in this country.

Family Holconoti or Embiotocoidæ.—The general appearance of the fishes upon which this family is founded, is that of our larger species of Pomotis, or rather that of the broader types of Sparoids. Their body is compressed, oval, covered with scales of medium size. The scales are cycloid, in which respect they differ widely from those fishes they resemble most in external appearance. The opercular pieces are without spines or serratures. Branchiostegal rays six. The mouth is encircled by rather thick lips; the intermaxillaries forming by themselves the whole margin of the upper jaw. The intermaxillaries and upper maxillaries are slightly protractile. Teeth only upon the intermaxillaries, lower maxillaries, and pharyngeals; none either upon the palatines or the vomer. In this respect, as well as in the absence of spines and serratures upon the opercular pieces, they differ much more from the Percoids, than from the Sparoids; but the cycloid scales remove them at once from the latter, in which the scales present a very uniform ctenoid type. The thick lips might remind one of the Labroids, but the scales of the Embiotoca are neither elongated, nor provided with the characteristic branching tubes of that family.

One long dorsal fin, the anterior portion of which is supported by spinous rays, and the posterior by numerous articulated branching rays, which are sheathed at the base by two or three rows of scales, *separated from those of the body by a rather broad and deep scaleless furrow.* This last peculiarity has not yet been observed in any fish, as far as I know. There is indeed a district longitudinal space parallel to the soft portion of the dorsal, nearly of the width of a single row of scales, which is entirely naked and well defined, forming as it were, a furrow between the scales of the back, and those which rest against the base of the fin rays. Though protected in this way by a kind of sheath, the anterior part of the dorsal fin alone can be folded backwards and entirely concealed between these scales, as in many Sparoids; the posterior part only partially so. Moreover the scales of the sheath are separated by a furrow from those of the back, only along the base of the soft part of the dorsal fin. The first rays of the anal fin are short, comparatively small and spinous. The base of this fin is strangely arched, and sheathed between scales, in the same manner as the dorsal; the spinous rays when folded back being more fully concealed in the sheath than the soft rays.

The ventrals are subthoracic as in the Sparoids, and provided with a strong spinous and five soft rays.

Four branchial arches, supporting four complete branchiæ with two rows of lamellæ in each. The opening behind the last arch is very small and entirely above the base of the pectoral fins. Pseudobranchia very large, and composed of sixteen or seventeen lamellæ. The alimentary canal is remarkably uniform in width for its whole length. It extends first on the left side as far back as the ventrals, turns forwards and upwards to the right, then follows the middle line along the *large air bladder*, to the second third of the abdominal cavity, then bends along the right side downward and slightly forwards almost to meet the first bend, when it turns backwards again, and ends in a straight course at the anus. The stomach cannot at all be distinguished externally from the small intestine by its size and form. There are no *cæcal appendages at all* in any part of the intestine. The whole alimentary canal contained large numbers of shell fragments of small Mytili. The liver has two lobes, a short one on the left side, and a long one along the middle line of the body.

The female genital apparatus, in the state of pregnancy, consists of a large bag, the appearance of which in the living animal has been described by Mr Jackson; upon the surface of it large vascular ramifications are seen, and it is subdivided internally into a number of distinct pouches, opening by wide slits into the lower part of the sac. This sac seems to be nothing but the widened lower end of the ovary, and the pouches within it to be formed by the folds of the ovary itself. In each of these pouches a young is wrapped up as in a sheet, and all are packed in the most economical manner, as far as saving space is concerned, some having their head turned forwards, and others backwards. *This is therefore a normal ovarian gestation.* The external genital opening is situated behind the anus, upon the summit and in the centre of a conical protuberance formed by a powerful sphincter, kept in its place by two strong transverse muscles attached to the abdominal walls. The number of young contained in this sac seems to vary. Mr Jackson counted nineteen; I have seen only eight or nine in the specimens sent by Mr Cary, but since these were open when received, it is possible that some had been taken out. However, their size is most remarkable in proportion to the mother. In a specimen of Emb. Jacksoni, 10½ inches long, and 4½ high, the young were nearly 3 inches long, and 1 inch high; and in an Emb. Caryi, 8 inches long, and 3¼ high, the young were 2¾ inches long, and ⅞ths of an inch high. Judging from their size, I suspected for some time that the young could move in and out of this sac like the young opossums, but on carefully examining the position of the young in the pouches, and also the contracted condition of the sphincter at the external orifice of the sexual organs, I remained satisfied that this could not be the case, and that the young Mr Jackson found so lively after putting them in a bucket of salt water, had then for the first time come into free contact with the element in which they were soon to live; but at the same time, it can hardly be doubted that the water penetrates into the marsupial sac, since these young have fully developed gills. The size of the young compared with that of the mother is very remarkable, being full one-third its length in the one, and nearly so in the other species. Indeed these young Embiotocæ, not yet hatched, are three or four times larger than the young of a Pomotis (of the same size) a full year old. In this respect these fishes differ from all the other viviparous species known to us. There is another feature about them of considerable interest, that while the two adults differ markedly in coloration, the young have the same dress, light yellowish-olive, with deeper and brighter transverse bands, something like the young trouts and salmons in their parr dress. The transversely banded species may therefore be considered as inferior to the other, since it preserves through life the system of coloration of the embryo.

It will be a matter of deep interest to trace the early stages of growth of these fishes, to examine the structure of the ovary and the eggs before fecundation takes place, &c., &c. The state of preservation of the specimens in my hands precluded every such investigation.

Though I know thus far only one single genus of this type, I do not think it right to combine the generic characters with those of the family, as is generally done in such cases, as I would also object to the practice of omitting any specific characteristics where only one species is known of a genus. This shows an entire misapprehension of the relative value and subordination of the characters of animals. I would therefore characterize as follows the genus.

Embiotoca, Agass.—Body much compressed and elevated. Head small, with scales only on the cheeks and opercular pieces. Teeth in both jaws, short, conical, arranged in one row, and slightly recurved. The pharyngeal teeth much shorter and blunter than those of the jaws, and arranged like pavement. Dorsal fin with nine or more spinous rays. The first three rays of the anal fin spinous, and much shorter than the following articulated rays, which are always finer and more numerous than the corresponding rays of the dorsal fin. The lateral line is continuous to the base of the caudal fin. Whether the peculiar mode of reproduction is a family or a generic character, remains to be ascertained by further investigations. It is, however, probable that with some slight modifications it will be found the same in all the members of the family.

Some differences between the two species observed might render it doubtful whether they ought to be considered as belonging to as many distinct genera or not. But we know that in genera differing greatly from others, the range of the specific differences is also wider than in genera with many species; so until I am taught differently by new discoveries, I would refer them both to one and the same genus. Such doubts could scarcely be entertained respecting families with many genera, where a standard to estimate genuine generic differences is easily obtained.

1. *Embiotoca Jacksoni*, Agass.—The body is quite high, of an oval form, greatly compressed, and similarly arched above and below. The superior arch extends to the posterior base of the dorsal fin, whence it continues in a horizontal line to the base of the tail. The ventral arch of the body is similar to that of the dorsal outline. The profile from the dorsal fin to the end of the snout is rather precipitate and regularly arched, except obliquely above and in front of the eyes, where it is slightly concave. The greatest height of the body, including the dorsal fin, is equal to the distance from the end of the snout to the extremity of the pectoral. The greatest thickness of the body is equal to one-fourth its height. The head is of moderate size,—its length, measuring to the posterior angle of the opercle, being about one-fourth that of the entire fish. The mouth is quite small,—the hind extremities of the intermaxillaries and maxillaries extending not farther back than the line of the orbit. But a small portion of the superior

maxillary is exposed at the angle of the mouth. The anterior edge of that part of the snout into which the intermaxillaries fit, is on a horizontal line drawn immediately below the orbits. The upper jaw is slightly more prominent than the lower, the teeth of the latter fitting *within* those of the former. In the upper jaw there are fourteen or fifteen teeth; in the lower there are two or three less. They all are slightly swollen near the top, and are not pointed but rather bluntly edged. They do not extend to the angles of the mouth, but leave a space without teeth on each jaw. The teeth of the upper jaw are but little larger than those of the lower. The teeth of the pharyngeals are much shorter than those of the jaws, and form two quite moveable plates above, and a triangular one below. There are not more than thirty teeth on each of the superior plates, and mostly truncated at the top. The four or five teeth which form the inner row of each plate are more prominent than the others, and somewhat pointed. The teeth of the inferior pharyngeal plate are similar to those of the upper, but the teeth of its posterior range are the most prominent, and pointed. The lips are rather fleshy, and entirely conceal the teeth. Beneath the lower lip there is an elongated pit on each side, extending towards the corner of the mouth; it is covered by a thin border of the lip. The distance from the end of the snout to the anterior border of the orbit, is greater than the diameter of the latter by one-third. The inferior margin of the orbit is on the middle longitudinal line of the body; and its posterior border is half way between the end of the snout, and the posterior angle of the opercle. The opercular pieces are large. On the preopercle are four concentric rows of scales; the two inner and anterior are the longer. There are thirteen large scales in the row nearest the eye, and the number is less and less in the others. Still within the row nearest the eye there is a space without scales, and marked by pores radiating from the edge of the orbit. The posterior and inferior border of the preopercle, outside of the ridge of the latter, is thin, membranous, and without scales, but marked with numerous pores or tubes similar to those around the orbits, and radiating from within outwards.

The opercle, subopercle, and interopercle are covered with scales, which decrease in size from the former to the latter. There is a narrow membranous border to the opercle, extending from its posterior angle to the height of the termination of the lateral line. The notch between the subopercle and interopercle is on a vertical line with the edge of the posterior border of the preopercle. There is a small patch of scales, nine or ten in number, immediately above the superior attachment of the preopercle. The dorsal fin extends over about $\frac{3}{5}$ths of the superior curve of the body; its posterior portion is one-third higher, as well as longer, than its anterior. The spinous portion has nine or ten rays, the length of the first of which is equal to one-third that of the last. At the point of each spine the fin appears to extend backwards in a loose filament. There are $19\frac{1}{2}$ articulated rays in the dorsal fin: the superior outline of this part is nearly equal in length. The furrow on each side extends as far forwards as the base of the first articulated ray, where there are three rows of scales forming the sheath; but the rows are reduced to one towards the posterior attachment of the fin.

The pectoral fins are of rather large size, and are placed below the middle line of the body, as well as below the posterior angle of the opercle. They extend about as near to the anal fin as do the ventrals. The second ray of the pectoral is but slightly arched towards its extremity. There are twenty-one rays in each pectoral. The base of the ventrals are just in advance of the middle of this second ray of the pectoral. The spinous ray of the ventrals is $\frac{3}{5}$ths the length of the following articulated ray. There is a long plate of scales between the ventrals. The anal fin is broad, and composed principally of fine slender rays. The last and longest of its spinous rays equals in length $\frac{1}{4}$th that of the following articulated ray, which latter is equal to the corresponding ray of the dorsal fin. The last ray of the anal fin is placed nearer the caudle fin than that of the dorsal.

The fin itself reaches nearer the base of the tail. The caudal fin is deeply forked; it contains fourteen rays, omitting its outer and short rays. There are eight rows of scales between the lateral line and the spinous portion of the dorsal fin, and eighteen rows below the lateral line in the same region. Sixty scales in the lateral line. Colour uniformly dark olive-brown along the back, fading slightly upon the sides; dorsal black, mottled with white; caudal blackish, lighter upon the base; anal deep black, with a light longitudinal band; pectorals white; ventrals black with light base.

From the above description, it must be obvious that this is the species first observed by Mr A. C. Jackson, to whom I have inscribed it, or at least a species very closely allied to it. There is only one fact about it which surprises me, that while he observed mature young in it on the 7th of June, Mr T. G. Cary should have found it still with young as late as the beginning of August. Again Mr Jackson saw nineteen young in it, whilst in the specimens forwarded by Mr Cary I found only eight or nine young, which were transversely banded like Emb. Caryi. May there be two species so closely allied as to be easily mistaken? I must add, that Mr Jackson does not mention the mottled appearance of the dorsal, nor the light band upon the anal of his fish; which renders the supposition more probable that there are several, and not only two species of this remarkable genus, about San Francisco. I would, however, not forego the opportunity of connecting the name of Mr Jackson with his interesting discovery, and have therefore called *Emb. Jacksoni* that one of the species sent me by Mr Cary, which agrees most closely with his description, leaving it for the future to decide whether this species is truly the one he first saw—a circumstance which is quite immaterial, since we already know two species of this extraordinary type.

2. *Embiotoco Caryi*, Agass.—The body is much more elongated than in Embiotoca Jacksoni, yet equally compressed. Its height, including that of the dorsal fin, is less than the distance from the end of the snout to the extremity of the pectoral; and less than one-half the length of the fish. The profile is much less steep, and the snout

quite as prominent; hence the head is longer than high. The posterior border of the orbit is nearer the angle of the opercle than the end of the snout. The upper and lower curves of the body are equal, and approach more nearly towards the tail, making this latter narrower than in the first species. The scales of the back do not descend upon the head lower than one-half the distance from the first spine of the dorsal to the end of the snout. The forehead is slightly concave, as in Emb. Jacksoni. The posterior end of the intermaxillary does not extend as far back as the anterior border of the orbit. The nature of the lips, and extent of the upper maxillary, is much as in the other species, but the anterior edge of the socket of the intermaxillaries is *above* the line of the lower border of the orbit. A vertical line through the orbit shows the height of the head in this region to be one-third less than in the E. Jacksoni. The opening of the mouth is directed more obliquely upwards. The teeth are more slender, but have otherwise the same form. In the upper jaw there are twelve, in the lower eight, teeth. The nasal openings are of tolerable size; one before the other, and in advance of the eye, but slightly below the line of its superior border. The vertical diameter of the orbit is less than its longitudinal; and its posterior border is nearer the angle of the opercle than the snout. The preopercle in this species is less rectangular than in the former. The inferior rounded angle of its *ridge* is in *advance* of the posterior margin of the orbit. The scales of the preopercle are also much smaller and less conspicuous. Tubes radiate from the border of the orbit and from the ridge of the preopercle, as in Emb. Jacksoni. The posterior membranous border of the opercle is narrower; the notch between the subopercle and interopercle is on the vertical line of the posterior border of the preopercle. There is a patch of scales above the superior attachment of the preopercle. The dorsal fin differs very little in form from that of the former, but extends somewhat farther forwards, its first spine being immediately over the posterior angle of the opercle. The distance from this spine to the end of the snout equals the distance from the *same* back to the ninth articulated ray. The posterior rays of the articulated portion are shorter than in the first species, but they are more numerous by three rays. The pectoral has twenty-one rays; it is perhaps longer than in the other. The ventrals differ little. The anal fin, however, differs greatly; it is very small and contracted, and is placed far behind the ventrals. The scales at its base form a waved outline much more marked than in E. Jacksoni. The spinous rays are very short, the last being less than one half the length of the following articulated ray, the base of which latter is directly under that of the fifteenth corresponding ray of the dorsal fin. Its posterior base and termination are as in the first species. The caudal fin, however, is more slender, and more deeply notched. The scales of the body are by no means so large. The lateral line follows the outline of the back, as in E. Jacksoni; there are seventy-five scales in it.

Colour light olive, darker along the back; light brown longitudinal bands extend between the rows of scales, and darker transverse bands reach from the back to the sides of the body, not extending below the lateral line in the anterior part of the trunk, but more marked, and reaching nearly to the anal fin upon the tail. Head mottled black and white. Dorsal and caudal dotted with black and white. Anal with a large diffuse black mark upon lighter ground. Pectorals white. Ventrals white at the base, terminated with black.

Only one female has been observed containing eight young. This species was discovered by T. G. Cary, Esq., in the Bay of San Francisco, in the beginning of August 1853.—(*American Journal of Science and Arts*, vol. xvi., p. 380.)

Experiments on the Dyeing Properties of Lichens. By W. Lauder Lindsay, M.D., Assistant Physician, Crichton Royal Institution, Dumfries. (Communicated by the Author.)*

I beg to present to the Society the tabulated results of between 500 and 600 experiments made two or three years ago, the chief object of which was the endeavour to call attention to the fact that we possess in our own island lichens capable of furnishing dyes nearly, if not quite, equal in beauty to orchil, cudbear, and litmus. I have so fully occupied the time of the Society on former occasions with detailed views on this subject, and with various papers on general points in the natural history of the lichens, that on the present occasion I confine myself to a few facts explanatory of the tables:—

I. Certain genera and species of lichens, which are abundant in Scotland, and could be collected with comparative facility, and at a very moderate expense, might be tried with advantage, on the large scale, as substitutes for the foreign lichens used in the manufacture of orchil, cudbear, and litmus. I have already indicated a favourable result in investigating native lichens on the small scale; but it remains for the manufacturer to test the permanence and utility of colours which may merely look brilliant without having any fixity.

II. This subject is worthy of being followed out by the manufacturer on the one hand, and the chemist on the other,—

- *a.* On account of scientific interest,—the field being comparatively new and open, and at the same time most promising of good results.
- *b.* Were it only with the view of further developing the economic resources of our own country.
- *c.* Because the speculation (*i.e.*, the substitution of home for foreign dye-lichens), promises to be remunerative, as the *roccellas* have frequently reached the high price of £1000 per ton in the London market.

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* This paper is partly a brief resumé or abstract of a series of communications to the Botanical Society of Edinburgh, made on various occasions during *the years* 1852, 1853, & 1854.

III. The collection and transport of lichens for the purpose of examining their colorific powers is very easy, viz. :—

- *a.* By simple desiccation and packing.
- *b.* By drying and pulverizing.
- *c.* By precipitating the colorific principles from a lime solution or a decoction by acetic or muriatic acid.

IV. The colour of the thallus and that obtained by the action of Stenhouse's or Helot's tests on solutions of the lichen-colorific-principles do not always correspond in tint; more frequently the reverse obtains; hence it is impossible from the colour or other external character of the thallus of a lichen to predicate the nature of the reaction of its alcoholic solution with chloride of lime, or the tint it will yield on ammoniacal maceration.

V. The lichens richest in colorific principles, capable of yielding valuable colouring matters, are crustaceous and foliaceous species of a pale or whitish colour—whose alcoholic or aqueous infusion is nearly devoid of colour—which grow on rocks or stones, and in mountainous countries, or on sea-coasts.

VI. The lichens most devoid of the same principles are species having a showy foliaceous thallus—attaining a considerable size—whose alcoholic and aqueous solutions are generally of the same colour with the thallus—and which grow on trees and in woods.

VII. The colours educible from lichens are liable to be materially affected, both as to quantity and quality, according to—

- *a.* Age of the specimen operated on, *i. e.*, length of period that has elapsed since collection and desiccation.
- *b.* The geologic or other nature of its habitat.
- *c.* The nature of its basis of support—whether moist or dry—rock, stone, tree, or earth, &c.
- *d.* The amount of exposure to sun-light and atmospheric oxygen.
- *e.* Amount of moisture in the air.
- *f.* Temperature of the locality.
- *g.* Elevation above the sea.
- *h.* Season and vicissitudes of the weather.
- *i.* Longitude and latitude in the two hemispheres.
- *k.* Decomposition of organic bodies in vicinity.

VIII. Westring's triple division of lichens according to the fixability or permanence of the colours they yield with or without mordants, &c.; and his quadruple division, according as these colours are extractable by cold, lukewarm, hot, or boiling water, aided or not by various accessories, are inconsistent and unnatural, and therefore not to be commended or followed.

IX. Westring's test of colorific power is inferior to Helot's or Stenhouse's; but all are frequently fallacious, and are far from being applicable in all cases. It is probable that different alkalies and reagents are suitable in different cases for the elimination of colouring matters.

X. The same circumstances, which modify the development of these colours on the small scale, cause material alterations in the results of manufacture. The result, however, is not always proportionate to the nature and amount of the modifying cause, insignificant circumstances frequently giving rise to most important and opposite changes.

XI. Speaking generally, the same process is equally applicable to the evolution of the red colouring matters of all lichens; but it is equally true that slight modifications of the process may cause a great variety in the degree or tint in any given species.

XII. The chief tint educible from lichens, which can be of any permanent utility in the arts, is *red: brown* is also useful in a minor degree.

XIII. Chloride of lime and aqua-ammoniæ are only suitable for the development of a *red* colour—or more strictly of colorific and colourless principles capable of conversion into red colouring matters.

XIV. Chloride of lime is not uniformly to be relied on as a lichen colorimeter; for Table xii. shows—

a. That the alcoholic solution of certain species may strike no blood-red colour with that reagent, and still yield beautiful red and purple colours on ammoniacal maceration; and

b. Table xiii. shows that though the alcoholic solution of some species do strike this colour (blood-red), it *does not* follow that ammoniacal maceration produces *the* same or a similar colour, or any colour at all.

XV. Simple maceration in a weak solution of ammonia, aided by a moderate heat and moisture, is the surest and simplest means of evolving the red colouring matters of the lichens.

XVI. Alcohol is an excellent solvent of the colorific principles of the plants, presenting them in a form readily acted on by chemical substances. Its use on the small scale is exceedingly convenient. The reaction of ammonia on a boiled alcoholic solution, allowed to stand for three days, is generally the same in tint, though not in degree, as on an aqueous solution exposed to the air for very long periods (1 to 12 months); but in some cases they differ essentially.—*Vide* Table xiv.

This difference is probably, in part, attributable to the small quantity of materials operated on, and the short period of maceration in the former case, and to the larger quantity of materials and the abundant exposure to atmospheric oxygen in the latter.

XVII. The non-evolution of colour in many cases may arise from—

- *a.* Alcohol or water not being the best or proper solvent menstruum of the colorific principles in any particular instance.
- *b.* Ammoniacal maceration not being the proper means of converting the colorific into coloured substances.
- *c.* The plant not containing colorific principles having the same chemical composition as orcine, &c., or showing similar reactions with chloride of lime and ammonia.

XVIII. If we accept, meanwhile, Stenhouse's and Helot's tests as sufficiently accurate indicators of colorific value, we should arrange the lichen genera, which contain species yielding colouring matters—according to their value—as follows:—

1. Roccella,
2. Lecanora,
3. Umbilicaria,
4. Gyrophora,
5. Urceolaria,
6. Parmelia,
7. Evernia,
8. Borrera,
9. Ramalina,
10. Lecidea,
11. Isidium,
12. Sphærophoron,

species of which yield fine *red* colouring matters; and

1. Parmelia,
2. Sticta,
3. Cetraria,
4. Nephroma,
5. Solorina,
6. Scyphophorus,
7. Stereocaulon,
8. Borrera,
9. Lecidea,
10. Peltidea,
11. Collema,

some of which furnish good *brown* colours.

XIX. Among the general results of my experiments it appeared that of 540 specimens examined,

22 Gave rich purple or red colours to ammonia alone, (*i.e.*, by simple maceration).
8 Gave rich brown colours to ammonia alone.
93 Alcoholic solutions gave rich purples or red on the addition of ammonia.
81 Alcoholic solutions gave well-marked brown on the addition of ammonia.
127 Alcoholic solutions gave well-marked orange on the addition of ammonia.
42 Alcoholic solutions gave well-marked greenish-yellow on the addition of ammonia.
79 Alcoholic solutions struck a deep blood-red with solution of chloride of lime.

XX. The whole subject of the intimate chemistry of the lichen colouring matters is in a very unsatisfactory condition, demanding reinvestigation ; and I therefore repeat, that the branch of the Natural History of the Lichens, to which, in this and previous papers, I have endeavoured to draw scientific attention, will form a worthy object of research to the botanist and chemist, and possibly a remunerative one to the wholesale manufacturer.

[If commanders and masters of ships were aware of the value of these plants, which cover many a rocky coast and barren island, they might, with a slight expenditure of time and labour, bring home with them such a quantity of these insignificant looking plants as would realize considerable sums, to the direct advantage of themselves and the shipowners ; and consequently to the advantage of the state. It is with the view of inciting those to whom the opportunity may offer, of gathering a valuable article of commerce, the value of which they would little suspect from its external aspect, and inducing the owners of vessels to direct the attention of their officers to this subject, that I subjoin some simple methods (says Dr Lindsay) of detecting the various *Lichens.]*

TABLE I.

Showing the Number of Species *of each Genus, with the* varieties *and duplicate* specimens *thereof, experimented upon.*

Name of Genus.	No. of species.	No. of varieties.	Duplicate specimens.[*]	Total specimens examined.
Alectoria,	3	4	1	8
Bæomyces,	2	...	1	3
Borrera,	6	2	6	14
Cetraria,	5	4	6	15
Cladonia,	10	12	6	28
Collema,	12	1	8	21
Cornicularia,	6	2	4	12
Endocarpon,	5	5	1	11
Evernia,	2	1	3	6
Gyrophora,	10	1	16	27
Isidium,	3	...	3	6
Lecanora,	32	8	9	49
Lecidea,	38	8	12	58
Lepraria,	2	1	1	4
Nephroma,	3	2	...	5
Parmelia,	36	28	27	91
Peltidea,	6	2	5	13
Pertusaria,	2	...	4	6
Placodium,	4	...	...	4
Psora,	3	...	...	3
Ramalina,	6	4	15	25
Roccella,	3	...	10	13
Scyphophorus,	12	8	13	33
Solorina,	2	...	3	5
Sphærophoron,	1	1	5	7
Spiloma,	1	...	...	1
Squamaria,	9	1	5	15
Stereocaulon,	6	1	...	7
Sticta,	5	...	6	11
Thelotrema,	1	...	...	1
Umbilicaria,	1	...	2	3
Urceolaria,	5	8	4	17
Usnea,	3	5	8	16
Variolaria,	1	...	...	1
Verrucaria,	1	...	...	1
Totals,	247	109	184	540

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[*] Specimens of the same species or variety, collected in different countries, different habitats in the same country, or at different seasons of the year.

TABL

Showing the effects of various Solvents and Reagen

Name of Solvent or Reagent.	Period of Maceration.	Roccella tinctoria.	
		Thin variety from Lima.	Thickest variety from Lima.
I. WATER—common spring—cold	14 days	Very pale sherry*	Dirty brownish-red
... at temperature of 80°	10 days	Light claret	Light Claret
... ... 120°	14 days	...	Deeper claret
... Boiling	½ hour	Dirty brownish-red	Dirty claret colour
... Distilled—cold	10 days	Pale sherry	Pale sherry colour
II. ALCOHOL [Spirits of wine].	10 days	Unaltered	Unaltered
III. ALKALIES—			
Ammonia			
Liquor—strong	3 days	Lt. crimson-purple	Rich crimson-purple
— dilute	10 days	Deep crimson-purple	Rich deep purple
Carbonate—solution, 2 grs.†	14 days	...	...
Muriate—solution, 2 grs. — cold	14 days	Pale brownish-red	Pale sherry
— sol. at temp. of 80°	7 days	Deeper brownish-red	Light claret
POTASH			
Aq. potassæ—			
— strong	3 days	Light claret	Deep claret
— dilute	10 days	...	...
Acetate, 2 grs.	14 days	Pale sherry	Very light claret
Bitartrate, 3 grs.	14 days	Very pale sherry	Pale sherry
Carbonate, 2 grs.	14 days	Brownish-red	Deep claret
Iodide of potassium, 2 grs.	14 days	Very light red	Light brownish-red
Nitrate, 5 grs.	14 days	Pale brownish-red	Brownish-red
Prussiate, 2 grs.	14 days	Unaltered	Unaltered
Sulphate, 2 grs.	14 days	Nearly unaltered	Nearly unaltered
SODA—			
Bicarbonate, 2 grs.	14 days	Light brownish-red	Deep sherry
Biborate (borax), 2 grs.	14 days	...	...
Carbonate, 4 grs.	14 days	Cherry red	Deep claret
Chloride of sodium, 5 grs.	14 days	Pale sherry	Pale sherry
Phosphate, 2 grs.	14 days	Pale sherry	Light brownish-red
ALKALINE EARTHS—			
Baryta—nitrate, 2 grs.	14 days	Very light br.-red	...
Lime, 2 grs., milk of— cold	14 days	Light sherry	Light purple-red
— boiling	1 hour	Dirty sherry	Deep purple-red
— at temp. of 80°	7 days	...	Rich purple-red
Chloride of calcium, 2 grs.	14 days	Light brownish-red	Light brownish-red

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* *I have been somewhat embarrassed in the naming of these colours.* I endeavoured to arran
ry *different from that in common use.*

he *number of grains* appended to this and other salts signifies the proportion in which *evolution of the Colouring Matters of Lichens.*

ccella tinctoria.			
m Cape De Verde Islands.	Roccella fuciformis from the Canaries, &c.	Lecanora tartarea from Perthshire.	Parmelia parietina from Grange, Edinburgh.
brownish-red	Light brownish-red	Pale sherry	Pale straw-colour
brownish-red	Dark brownish-red	Dirty sherry	Dirty greenish-yellow
...	...	...	...
sherry colour	...	...	...
t brownish-red	Light sherry	Light brownish-red	Straw-yellow
tered	Unaltered	Dirty reddish-brown	Pale yellow
crimson-purple	Light brownish-red	Rich deep purple	Dirty greenish-yello
purple	Dark purple-red	...	...
...	...	...	...
t sherry	Light brownish-red	Pale sherry	Pale greenish-yellow
claret	Deeper brownish-red	Rich sherry	...
t brownish-red	Pale sherry	Purple-red	Dirty greenish-yellow
er brownish-red	Brownish-red	Rich purple	...
t brownish-red	Light brownish-red	Deep claret	Pale straw-colour
...	...	Deep sherry colour	...
lish-red	Deep claret	Rich purple	...
nish-red	Pale sherry	Deep claret	...
t sherry	Light brownish-red	...	...
tered	Unaltered	Light claret	...
ly unaltered	Nearly unaltered	Sherry colour	...
sherry	Light brownish-red	Purple-red	...
...	...	Deep brownish-red	...
brownish-red	Deep brownish-red	Purple-red	...
lt. brownish-red	Very lt. brownish-red	Pale sherry	...
...	...	Light brownish-red	...
...	...	Sherry colour	...
t brownish-red	Pale sherry	Light purple-red	...
er brownish-red		...	...
...	Fine claret	Deep purple-red	...
t brownish-red	Brownish-red	Light sherry	...

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ccording to the tables in "Syme's Nomenclature of Colours." His nomenclature, however,

ed to each fluid ounce of water.

Name of Solvent or Reagent.	Period of Maceration.	Roccella tinctoria.	
		Thin variety from Lima.	Thickest variety from Lima.
Lime—Sulphate, 5 grs.	14 days	Nearly unchanged	Light brownish-red
Magnesia—			
Sulphate, 5 grs.	14 days	Light brownish-red	...
EARTHS PROPER—			
Alumina—			
Alum, 5 grs.	14 days	Colourless	Light brownish-red
Combinations of			
Lime and sal-ammoniac, 1 g.			
Macerated cold	14 days	Light orange-red	Light claret
— warm	4 days	Deep orange-red	Deep claret
Common salt and nitre, 2 g.			
macerated cold	14 days	Deep sherry	Purple-red
macerated warm	4 days	Fine claret	Deep red
Carbonate of soda & nitre, 3 g.			
— cold	14 days	Deep claret	Deep claret
— warm	4 days	...	Deep purple-red
IV. METALS, and their salts—			
Iron—perchloride, solution	7 days	Unaltered	Unaltered
— sulphate, 1 gr.	7 days	Unaltered	...
Arsenious acid, 1 gr.	7 days	Brownish-red	Brownish-red
Copper—sulphate, 1 gr.	7 days	Unaltered	Unaltered
Lead—acetate, 2 grs.	7 days	Nearly unaltered	Brownish-red
Zinc—sulphate, 2 grs.	7 days	...	Unaltered
V. ACIDS—			
Acetic—common vinegar	14 days	Unaltered	Unaltered
— strong vinegar	14 days	...	...
— pyroligneous acid	14 days	. .	...
Nitric—strong	1 day	Colourless	Colourless
— dilute	14 days	...	...
— — cold		...	...
— — warm	14 days	...	...
Muriatic—strong	1 day	Colourless	Colourless
— dilute		...	...
— — cold	14 days	...	...
— — warm	14 days	...	...
Oxalic, 1 gr.	14 days	...	...
Sulphuric—strong	1 day	...	...
— dilute		...	...
— — cold	14 days	...	...
— — warm	14 days	...	...
Tartaric, 2 grs.	14 days	Brownish-red	

Vide Explanation, p. 248.

Roccella tinctoria. From Cape De Verde Islands.	Roccella fuciformis from the Canaries, &c.	Lecanora tartarea from Perthshire.	Parmelia parietina from Grange, Edinburgh.
arly unaltered	Palest sherry	Pale sherry colour	Unchanged
...	...	...	Colourless
arly unchanged	...	...	Nearly colourless
ownish-red	Light orange-red	Purplish-red	Pale straw-colour
rplish-red	Purple-red	Deep red	...
ret	Light claret	...	Dirty straw-colour
ep claret	Deep claret	...	...
ep sherry	...	...	Dirty lt. greenish-yel.
...	...	...	...
altered	Unaltered	Unchanged	Unchanged
...	...	Unaltered	...
arly unchanged	...	Dark claret	...
altered	...	Unaltered	...
arly unaltered	...	Dirty brownish-red	Dirty brownish-red
...	...	Nearly unchanged	...
altered	...	Colourless	Colourless
...	...	...	...
...	...	...	...
lourless	Colourless	...	...
...	...	...	...
...	...	...	...
...	...	...	...
lourless	Colourless	...	...
...	...	...	...
...	...	...	...
...	...	Deep claret	...
...	...	Colourless	...
...	...	...	...
...	...	...	...
...	...	...	...
...	...	Very pale sherry	...

TABLE III.

Showing the Species and Varieties the Alcoholic Solution of which gives a* red† *reaction with Solution of Chloride of Lime.*‡

Name of Lichen.	Fugitive.	Light tint.	Deep tint.
Borrera furfuracea, ...		Brown.	
Cornicularia aculeata ?	Cherry.		
Endocarpon Hedwigii, ...			
Evernia Prunastri, ...	Blood.		
Gyrophora deusta, ...	...		
erosa, ...		Cherry.	
murina, 3 specimens from Switzerland, Norway, and Scotland,	Cherry.	Cherry.	Blood.
hirsuta, 3 specimens from Switzerland and France, .		—	Cherry.
hyperborea, 2 specimens from Do.		—	—
pellita, 3 specimens from Scotland and France, . . .	Cherry.	—	Cherry.
polyphylla, 4 specimens from England, France, and Switzerland,	—	—	—
proboscidea, 3 specimens from Norway, France, and Scotland,		—	Blood.
vellea, ...	Cherry.	—	
Lecanora cœnisia, ...	—		
glaucoma, ...	—		
parella var. albo-flavescens,		Cherry.	Cherry.
tartarea, 3 specimens from Scotland, France, and Switzerland, .		Pink.	Blood.
Lecidea atro-pruinosa, var. microphylla,	Cherry.		

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* This merely means the result of boiling the comminuted lichen in weak spirit. It may be considered a solution of the colorific principles of the plant, as most of these are soluble in alcohol.

† This term includes light and dark shades of—

a. yellowish or orange red.
b. brownish-red, such as sherry and claret colours.
c. cherry, blood, or pinkish red.

The above list includes the greater number of the species useful as dye-agents. Most of them will be found to yield on ammoniacal maceration, rich red or purple tints, but not uniformly. (*Vide* Table xiii.)

‡ A solution of common bleaching powder. The active ingredient is probably the hypochlorite of lime it contains; so that, so far as concerns its use as a colorific test, this solution may be considered one of hypochlorite of lime.

Name of Lichen.	Fugitive.	Light tint.	Deep tint.
Lecidea conglomerata,	Cherry.		
dubia,		Cherry.	
fumosa,	...		
gelatinosa,	...		
impressa,			Blood.
incana,	Cherry.		
lurida,	Brown.		
speirea,			Blood.
quadricolor,	Cherry.		
Parmelia aleurites,	Brown.		
fahlunensis var. vulgaris,	Pink.	Cherry.	Claret.
olivacea var. corticola glabra,			Blood.
conspurcata,			—
omphalodes,		Orange	Brown.
perlata, 2 spec. from Scotland and the Canary Islands,	Pink.	Cherry.	Blood.
pulverulenta,		—	—
quercifolia var. munda,		—	
fuliginosa,		—	
stellaris,		Brown.	
tiliacea,		Cherry.	
Roccella fuciformis, 5 spec. from So. America,		Pink.	Purple.
Montagnei,		—	
tinctoria, 7 spec. from Africa, South America, and the Canary and Cape de Verde Islands,		—	—
Squamaria affinis,	Brown.		
Umbilicaria pustulata, 3 spec. from Scotland, Norway, and France,		Cherry.	Purple.
Urceolaria bryophila,	Pink.		
calcarea,		Cherry.	Blood.
scruposa, 3 spec. from France, England, and Scotland,		—	—
var. cretacea,	Cherry.		
arenaria,	—		
verrucosa,	—		
mutabilis,	—		

TABLE

Showing the effects or reaction of Solution of Chloride of Lime and
tint on the

	Reaction of Chloride of Lime.					
NAME OF GENUS.	Green-yellow deepened.		Bleached.		Brown or Brown-yellow Tint.	
	No. of Species.	Per Centage.*	No.	P. c.	No.	P. c.
Alectoria, .	3	45·0	...	...	...	...
Bæomyces, .	...	...	...	...	...	...
Borrera, .	2	14·3	4	36·1	...	...
Cetraria, .	5	33·5	3	20·0	...	...
Cladonia, .	5	18·0	...	...	...	...
Collema, .	...	...	5	25·3	...	...
Cornicularia, .	2	16·6	...	...	...	...
Endocarpon, .	...	..	...	...	...	...
Evernia, .	5	90·0	...	...	...	...
Gyrophora, .	...	...	...	...	...	...
Isidium, .	2	33·5	...	...	...	...
Lecanora, .	8	16·8	8	16·6	1	2·2
Lecidea, .	5	8·5	7	12·4	1	1·7
Lepraria, .	...	...	1	25·	...	...
Nephroma, .	1	20·0	1	20·	...	...
Parmelia, .	17	21·3	9	10·1	2	2·6
Peltidea, .	1	8·9	4	33·1	1	7·8
Pertusaria, .	1	16·6	1	16·6	...	...
Placodium, .	1	25·0	1	25·	...	...
Psora, .	...	...	...	...	1	33·3
Ramalina, .	5	20·0	1	4·	2	8·4
Roccella, .	...	...	...	...	...	...
Scyphophorus	12	32·2	1	3·1	1	3·4
Solorina, .	1	20·0	1	20·	...	...
Sphærophoron,	2	34·3	...	...	...	...
Spiloma, .	...	...	1	100·	...	...
Squamaria, .	5	33·6	4	23·1	...	...
Stereocaulon .	1	14·3	...	...	...	...
Sticta, .	1	9·1	3	35·1	...	...
Thelotrema .	...	...	...	...	...	...
Umbilicaria, .	...	..	..	...	...	...
Urceolaria,	...	...	1	5·8	...	...
Usnea, .	6	30·0	1	5·2	..	...
Variolaria, .	...	...	...	...	...	...
Verrucaria, .	...	...	...	...	...	...

These results may be considered negative so far as regards the object of my
of conversion, by chemical means, into useful colouring matters.

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* The percentage is only to be accepted as a very rough indication, and
number of *specimens* (not species) operated on, there is only an approximation

IV.

of Aqua Ammoniæ—other than the development of a Red or Purple Lichen Genera.

Re-action of Ammonia.						Chloride of Lime.	
Ill-marked.		Dull Orange.		Greenish-yellow.		No Change.	
No.	P. c.	No.	P. c.	No.	P. c.	No.	P. c.
3	35·	1	12·4	3	40·4	5	86·
...	...	3	100·	...	...	3	100·
2	14·5	2	14·6	5	34·1	7	50·
2	14·8	4	24·6	9	60·	7	54·5
3	11·1	12	44·5	11	43·8	26	96·
2	10·9	1	4.8	17	71·3	17	90·5
5	40·	1	8·4	6	50·	9	88·6
5	45·	...	...	8	80·4	11	100·
1	16·6	2	33·5	3	50·	...	...
10	40·3	2	7·9	...	...	4	18·5
2	33·5	3	50·	...	...	4	90·2
5	10·	9	19·8	17	30·6	21	56·5
8	14·8	17	30·4	11	20·6	28	51·6
...	...	...	...	3	90·0	2	50·
...	...	1	20·	3	85·1	3	76·8
15	16·6	19	19·1	35	30·5	43	58·6
5	43·3	1	7·8	5	44·6	5	43·8
1	16·6	2	33·5	3	50·1	4	88·6
...	...	...	...	3	89·2	2	50·
1	33·4	1	33·5	2	92·4	2	68·9
2	8·6	3	12·4	17	56.6	14	43·4
9	70·	...	...	...	...	...	...
7	24·	17	50·	6	20·4	21	78·6
2	44·3	...	...	1	20·	3	26·8
...	...	1	14·6	...	...	5	100·
1	100·	..	...	...	...	...	...
1	6·8	3	20·	5	33·5	5	33·5
...	...	1	14·6	4	80·7	6	93·2
2	21·	6	44·5	1	9·1	7	89·6
1	100·	...	...	1	100·	1	100·
...	...	1	33·5	...	...	...	...
1	5·8	6	32.6	3	17·6	6	31·6
...	...	1	6·4	9	90·3	8	50·
...	...	1	100·	...	..	1	100·
1	100·	...	...	...	...	1	100·

experiments, viz., the detection of species possessing colorific principles, capable

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not to be relied on as accurate; for, having been calculated from the total to the truth.

TABLE V.

Showing the Species the Alcoholic Solutions of which give, on maceration i *dilute* aqua ammoniæ, *various shades of* red *or* purple.*

Name of Lichen.	Red.		Purple.	
	Light.	Dark.	Light.	Da
Borrera Ashneh,	Cherry.		—	
chrysophthalma, 3 specimens from Zante, France, and Switzerland,	Pink.	Pink.	—	
Cetraria islandica,	Brown.	Brown.		
Gyrophora hirsuta, 3 specimens,		Cherry.		
pellita,		—	—	
polyphylla, 2 specimens,		—	—	
proboscidea,		—		
Isidium coccodes,	Cherry.			
Lecanora albella,	—			
atra,		Blood.		
callopisma,	—			
lutescens,	—			
oreina,		Blood.		
radiosa, v. inflata,		—		
speirea,		—		
sophodes,	Cherry.			
tartarea,	—		—	—
ventosa, 2 specimens,		Blood.	—	—
Villarsii,		—		
Lecidea aurea,	Cherry.			
commutata,	—			
coronata,	—			
erythrella, v. fusco—virens,			—	
icmadophila, 2 specimens,	Brown.			
sanguinaria,				—
speirea,		Blood.		
uliginosa,		—		
Wahlenbergii,	Cherry.			

---

* Alcohol appears to be an excellent solvent of the active colorific principles of the pl presenting them in a condition to be readily acted on by ammonia or other reagents. The results of the reaction of ammonia on the alcoholic solution, is generally simila the effect of simple ammoniacal maceration, so that this mode of applying Helot's te a very convenient and elegant one. There is sometimes, however, a considerable differ *between the effects of* ammonia on the alcoholic and aqueous solution. (*Vide* Table xiv.

Name of Lichen.	Red.		Purple.	
	Light.	Dark.	Light.	Dark.
hroma resupinata,	—			
melia aleurites,		Cherry.		
Borreri,		Blood.		
caperata,		Brown.		
v. membranosa,		—		
conspersa, 3 specimens,		Cherry.		
encausta,		—		
omphalodes, 2 specimens,		Brown.		
ostreata,	Cherry.			
parietina, 2 specimens,	Pink.			
perlata, 3 specimens,		Blood.	—	—
saxatilis, 2 specimens,		Brown.		
v. furfuracea, 2 specimens,		—		
v. leucorrhœa,		—		
idea aphthosa,	Brown.			
polydactyla,		Brown.		
tusaria communis,	Cherry.			
alina fraxinea,	—		—	—
farinacea,	—		—	
cella tinctoria, 2 specimens,	Cherry.	Blood.	—	—
phophorus bellidiflorus,		Brown.		
cervicornis,		—		
cocciferus,		—		
deformis,		—		
digitatus,		—		
filiformis,	Brown.			
rina crocea, 2 specimens,		Brown.		
ærophoron coralloides, 2 specimens,	Cherry.			
v. fragilis,	—			
v. cæspitosum,	—			
amaria candelaria, 3 specimens,	Pink.			
miniata, 2 specimens,	—			
eocaulon botryosum,	Brown.	Brown.		
ta pulmonaria,		Brown.		
scrobiculata, 2 specimens,		—		
bilicaria pustulata,		Blood.	—	—
eolaria cinerea,		—	—	
scruposa,		—	—	—
v. ocellata,		—	—	—
ea barbata,		Brown.		
v. articulata, 2 specimens,		—		
lonia bacillaris,	Cherry.			
ema nigrescens,		Brown.		

TABLE VI.

Showing the Species, the Alcoholic Infusions of which give, on maceration in dilute aqua ammoniæ, *various shades of* orange.*

Name of Lichen.	Yellow tint predominant.	Red tint predominant.
Bæomyces roseus,	Light.	
rufus, 2 specimens from France and Switzerland,		Deep.
Borrera furfuracea, 2 specimens,	Deep.	
Cetraria islandica, 3 specimens from Norway, England, and France,		—
Cladonia degenerans,	—	
v. alabra,		—
furcata, 2 specimens from France and Switzerland,	—	—
v. racemosa, 2 specimens,		—
rangiferina, v. vulgaris,		—
sylvestris,	—	
uncialis,	—	
incana, v. polydactyla,	—	
vermicularis, v. subulifera,		—
Collema marginale,		—
Cornicularia pubescens,	—	
Evernia Prunastri, 2 specimens,	—	
Gyrophora cylindrica,		—
murina,		—
hyperborea,	—	—
Isidium coccodes,	—	
coralloides, 2 specimens from England and France,	—	
Lecanora cænisia,		—
hæmatomma,		—
parella,	—	
v. pallida corticola,	—	
v. albo—flavescens,	—	
speirea,	—	
tartarea,	—	
v. rupestris,		—
Turneri,	—	

---

* Though this tint is greatly inferior in richness or usefulness to the red and purple, many of the above species yield very good dye agents. The orange is, in many cases, capable of conversion into red and purple by chemical means.

Name of Lichen.	Yellow tint predominant.	Red tint predominant.
Lecidea atro-pruinosa, v. anthracina,	—	
candida,		—
conglomerata, 2 specimens,	—	
dubia,	—	
flavo-virens, v. fusco-virens,	—	
gelatinosa,	—	
granulosa,		—
impressa,	—	
lapicida,	—	
lurida,		—
nigrita,	—	
sabuletorum, v. fusco-cinerea,		—
squalida,	—	
speirea,	—	
quadricolor,		—
vernalis,	—	
Nephroma parilis,		—
Parmelia aleurites,		—
caperata,		—
cæsia,		—
diatrypa,		—
fahlunensis, v. vulgaris minor,	—	
glomulifera,		—
olivacea,	—	
ostreata,		—
physodes,		—
v. vittata, 2 specimens,		—
perlata,		—
quercifolia, v. munda,		—
v. fuliginosa,		—
rupestris, v. flaccida,		—
saxatilis,		—
stellaris,		—
stygia,		—
v. pulverulenta,	—	
tiliacea,	—	
Peltidea canina,	—	
Pertusaria communis,		—
fallax,	—	
Psora decipiens,		—
Ramalina fraxinea, 2 specimens,		—
scopulorum,		—
Roccella fuciformis, 6 specimens,		—
Montagnei,		—

Name of Lichen.	Yellow tint predominant.	Red tint predominant.
Scyphophorus cervicornis, 3 specimens from England, Scotland, & France,	—	—
cocciferus, 3 specimens,		—
gracilis, 3 spec. from France, England, & Scotland,	—	
v. abortiva,		—
chordalis,	—	
polyceras,	—	
pyxidatus, 3 specimens,		—
v. communis,	—	
neglecta,	—	
sparassus,	—	
Sphærophoron coralloides,		—
Squamaria cæsia,	—	
clementi,	—	
lanuginosa, 2 specimens,		—
Stereocaulon paschale,	—	
Sticta fuliginosa, 2 specimens,		—
pulmonaria, 2 specimens,		—
scrobiculata,		—
sylvatica,		—
Umbilicaria pustulata,	—	
Urceolaria calcarea,		—
foveolaris,	—	
scruposa, 3 specimens,		—
Usnea barbata, v. articulata,	—	
Variolaria faginea,		—

TABLE VII.

Showing the Species, the Alcoholic infusions of which give, on maceration in dilute aqua ammoniæ, *various shades of* brown.[*]

Name of Lichen.	Yellow tint predominant.	Red tint predominant.	Pure Brown.
Alectoria jubata,	—		
Borrera furfuracea,		—	
tenella,	—		

---

[*] Few of the species yielding good brown dyes are capable also of giving red or purple ones. But this colour is a very durable, and, therefore, useful one; it is extensively employed among the peasantry in this and other countries. The processes for developing it are much more simple; but the lichens *yielding brown* dyes alone have never been articles of commerce.

Name of Lichen.	Yellow tint predominant.	Red tint predominant.	Pure Brown.
Cetraria islandica,		—	—
nivalis,	—		
Cladonia bacillaris,		—	
cænotæa,	—		
uncialis,	—		
Collema crispum	—		
nigrescens,		—	
saturninum,	—		
Cornicularia aculeata,	—		
bicolor,	—		
lanata,	—		
ochroleuca,	—		
tristis,	—		
Endocarpon fluviatile,	—		
Hedwigii,	—		
miniatum,	—		
Evernia divaricata,	—	—	
Gyrophora cylindrica,	—		
deusta,		—	
erosa,		—	
murina,		—	
hyperborea,		—	
pellita,		—	
polyphylla,		—	
proboscidea,		—	
vellea,		—	
Isidium coralloides,		—	
lutescens,	—		
Lecanora badia,	—		
callopisma,		—	
circinnata,	—		
chlorophana,	—		
epigæa,	—		
parella, v. pallida,		—	
murorum,	—		
Lecidea atro-brunnea,	—		
atro-pruinosa,	—		
cæruleo-nigrescens,	—		
fumosa,		—	
incana,	—		
pannæola,	—		
armeniaca,		—	
Parmelia centrifuga,		—	
crassa,		—	

Name of Lichen.	Yellow tint predominant.	Red tint predominant.	Pure Brown.
Parmelia cycloselis,	—		
cæsia,	—		
fahlunensis,		—	—
Lamarckii,		—	
multifida,	—		
olivacea,		—	—
omphalodes,		—	—
perlata,		—	
pulverulenta,		—	
rupestris,		—	
stygia,		—	—
Peltidea canina,	—	—	—
aphthosa,	—		
horizontalis,	—		
Pertusaria communis,	—		
Psora testudinea,	—		
Ramalina pollinaria,		—	
scopulorum,		—	
Roccella fuciformis,		—	
Montagnei,		—	
tinctoria,		—	
Scyphophorus alcicornis,	—		
digitatus,	—	—	
fimbriatus,	—		
gracilis,	—		
pyxidatus,	—	—	—
gracilis,	—		
Solorina saccata,		—	
Spiloma gregarium,	—		
Squamaria candelaria,	—		
Sticta crocata,		—	
scrobiculata,		—	
Thelotrema lepadinum,	—		
Urceolaria scruposa,		—	
barbata,		—	
Verrucaria leucocephala,	—		

Explanation of Table II.

This table serves fully to illustrate—

I. The negative action of all acids in evolving the colorific principles of lichens, or converting them into coloured substances.

II. The powerful action of certain alkalies and alkaline salts, especially ammonia and its compounds, in the production of colour-production and metamorphosis.

III. The influence of heat, moisture, exposure to atmospheric oxygen, &c., in assisting the development of the lichen colouring matters.

a. Several other species were operated on; various other combinations of the alkalies and alkaline earths, &c., and other reagents were used; the experiments were conducted in the greatest possible variety, as regards the amount of heat and exposure to the air, the length of the maceration, the strength and degree of dilution of the reagents, &c.; but the results, though differing sometimes slightly, or in some insignificant features, were essentially the same.

b. The period of maceration varied from a few hours to as many weeks or months; the shortest was half an hour, the longest period a year. Beyond a certain point, prolonged maceration did not appear materially to affect the nature or degree of tint; nay, in some cases, the colour was greatly deteriorated or destroyed. In some species, the colouring matters were rapidly produced; in others, again, very slowly; in the former case, therefore, a short, while, in the latter, a long period of maceration was necessary.

c. The same remarks apply to the degree of heat applied; up to a certain point, it is an important auxiliary, but beyond this it becomes very deleterious.

d. During the course of the experiments, some of the solutions very rapidly became mouldy, while others stood for nine months or a year with little or no appearance of mould of any kind. It is foreign to my present subject here to specify the instances in which this phenomena did or did not occur; the results possess interest merely as showing the effects of certain chemical reagents in promoting, retarding, or destroying the development and growth of fungi.

e. In some of the solutions, a flocculent, or granulo-flocculent precipitate was thrown down. Of the nature of this, in most cases, I am unable to speak, the question being a purely chemical one; but, in some instances, it undoubtedly consists of the colorific principle of the plant.

f. After the exhaustion of the red colouring matter of *Lecanora tartarea* and the *Roccellas* by ammonia, they yielded very rich crimson tints to alcohol; and similar, though less brilliant, colours to solutions of carbonate of potash and carbonate of soda, &c.

g. In some cases, the full colour was evolved only on second maceration, or after the application of a series of reagents.

h. In the case of solutions of salts used as macerants, the quantity or proportion of grains to the ℥i of water is given,

[*To be continued in the January Number of Jameson's Journal.*]

The Old World compared with the New World. By M. Marcel de Serres, Professor of Mineralogy and Geology at Montpellier.*

The Earth, like Man himself, has had its different phases; after having passed through its infancy, it has now reached mature age, and it is in this state that it presents itself to our notice. Our globe is far indeed from having always been what it is in the present day, and we shall endeavour to trace the various modifications it has undergone at different periods of its history (*See Note* 1, p. 258).

The air we breathe, for example, is not the same as that from which the beings that preceded us here below derived the powers of life (*See Note* 2). The seas which cover nearly three-fourths of the earth's surface (*See Note* 3), have been more extensive still at the time when continents scarcely equalled the extent of moderate sized islands (*See Note* 4). None of the animals which now people our planet, nor the vegetables by which it is adorned, existed in those remote ages, when there was no human being to behold them.

I have said that the atmosphere was not the same in composition in former times as it is now. Let us examine what proofs we have for this fact, which is the more singular from no change having appeared in it during historical times, and indeed scarcely seems possible.

Primitive vegetation, of the kind most remarkable for vigour and beauty, has left us indubitable proofs of it. These are to be found in the immense masses of coal, the remains of the ancient forests which covered the surface of the earth. But from what quarter have the trees of these forests derived this vast quantity of carbon, now become the source of so many industrial occupations? Did it exist in the soil? The soil could not supply it, since as yet it contained neither humus nor any kind of vegetable substance. They found it in the great proportions of it which existed in the atmosphere (*See Note* 5). This excess of carbonic acid was singularly favourable to the vegetation of primitive times, while it in some degree arrested the development of air-breathing animals, which had scarcely begun to show themselves. After the appearance of life, fishes were the only vertebrates which animated our earth; but these animals only breathe air dissolved in water, richer in oxygen than the atmospheric air itself.

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* *Outline* of a Lecture lately delivered by M. Marcel de Serres.

Now, that the atmosphere contains a much greater quantity of vital air than during geological eras, the species which breathe air are as common in nature as they were formerly rare. It may almost be said that the arrival of Man has for ever fixed the constancy of the proportions of carbonic acid in atmospheric air; at least they do not appear to have varied since that event.

Vegetables also found a new cause of development in the carbonic acid which volcanoes, then more numerous than now, diffused through the atmosphere. These striking phenomena, moreover, supplied them with abundance of ammoniacal salts, which contributed in a powerful manner to impart to them a vigour which has never been surpassed.

If we compare primitive vegetation with the flora of existing times, we shall soon perceive that none of the species which characterised it are like our living races; they merely present some analogies to the plants of islands now situated in the warmest and most humid regions. Are we not, then, authorized to regard this double circumstance as a manifest proof of the influence which an elevated temperature, and, at the same time, a considerable humidity must have exercised on primitive vegetation?

Little doubt will be entertained on the subject, when we consider that the same fossil animals and plants are spread from Spain to the polar circle, and from South America as far as Australia and Van Diemen's Land (*See Note* 6). Therefore, the same vegetables, embedded in coal formations, have in former times lived simultaneously in the two hemispheres, as well in the torrid zone as under the ice of the poles (*See Note* 7).

From these facts, we infer that the heat must then have been uniform everywhere, and that the sun had not yet regulated and determined climates. The earth had not then need of his rays, since terrestrial temperatures depended on an entirely different cause. Their effect was to render climates generally alike, as well as the natural productions to whose development they were alone favourable.

This primitive uniformity could not, however, continue: it accordingly ceased altogether on the appearance of Man. If it had lasted, it would have partially destroyed the physical and intellectual energy of our species. It likewise proves that, independently of the heat which the earth owes to the sun, it derives it also from another source. That source is in its own bosom, and its action has for a long time regulated, almost of itself, the greater part of terrestrial phenomena. The central heat, which with Buffon was only an hypothesis, must now be regarded as a fact almost demonstrated.

It is so, more especially by this remarkable circumstance, that the heat, instead of diminishing below the terrestrial strata, where the calorific rays of the sun are no longer felt, increases in proportion to the depth (*See Note* 8). It is still further evinced by volcanic eruptions, and the constant temperature of thermal springs. These phenomena clearly indicate that a powerful source of heat must exist in the interior of the globe. We find, moreover, a new proof of the same thing in the general form of the earth, which has not depended solely on the movement imparted to it, but on its primitive liquidity (*See Note* 9). The earth has not derived this liquidity from water nor any other solvent, but rather from the action of a high temperature. This temperature is singularly diminished since the origin of things; it does not, at least at the present time, affect the heat of the surface more than the thirtieth part of a centigrade degree.

It may be safely affirmed, that if the earth lost entirely this degree of heat, which it does not derive from the sun, it would not, on that account, become an inert and frozen globe, as Buffon supposed, when he expressed his belief that

Man was destined in time to perish from cold. We have no occasion to give way to such an apprehension. The diminution of the central heat, far from injuring, may perhaps be of advantage to us. It will contribute at least to give additional thickness to the crust of the earth, and, by confirming its solidity, render earthquakes and other phenomena which shake the surface of the globe of rarer occurrence.

The terrestrial globe is, as we thus perceive, a singular habitation. Solid beds, of inconsiderable thickness, separate us from subterranean fires; and a gaseous mixture scarcely a score of leagues in height (*See Note* 10) protects us against the glacial cold of the interplanetary regions (*See Note* 11). We thus revolve in space with an extreme rapidity, of which we are unconscious, and often without suspecting the singularity of our abode. We may inhabit it without fear;—thanks to the harmony which reigns among created things, not only in this earth, but throughout the entire universe.

Positive facts confirm the reality of the conditions which we have enumerated, and which have determined the beauty and richness of the vegetation of the earliest geological eras. An elevated temperature and a considerable humidity, arising from the great extent of the seas and the activity of evaporation, have powerfully contributed to this result.

These different causes have produced rain-torrents, of which nothing in the present day can give us any idea. The proof of their violence is written in the interior of the earth's strata, where what are believed to be traces of them have been found. They were probably never accompanied, in the early ages of the world, with the symbol of peace painted in prismatic colours on the sky, as happens in certain parts of America, where the rains are of such extreme violence that they cannot produce this brilliant phenomenon. Finally, ancient inundations indicate, by their extent, that they must have been the effect of more considerable masses of water than those which now produce even the greatest floods. Such is the Deluge, of which the tradition is preserved among every people, and which is attested by so many indisputable physical proofs.

We have reminded you of the extent of seas during geological times; you ought not therefore to be surprised that the examination of terrestrial strata enables us to discover so great a number of marine organic remains, often at considerable elevations, and very remote from the basin of existing seas (*See Note* 12). The ancient ocean has therefore occupied the places where these remains appear; as marine products are diffused over extensive spaces, the ocean must have been vastly greater than it is in the present day (*See Note* 13).

But let not this lead you to suppose that the level of seas has ever reached the height of 2000 or 3000 metres above their present elevation. If we discover beings which have lived in their bosom at such elevations, they have been carried thither from the bottom of the ocean by upheavals; this powerful cause has, in fact, greatly modified the surface of our planet, and is quite adequate to produce such effects (*See Note* 14).

It is unnecessary to prove to you who now hear me, that the seas of geological eras occupied a greater extent than those of the present world. If any one, however, have any doubts on the subject, we should say to him, Dig into the ground on which this city stands, and if the marine remains you find there do not satisfy you, examine the beds which separate us from the Upper Cevennes, and you will everywhere meet with proofs of the long continued presence of the sea in districts which are now very remote from it.

Science has not stopped here; she has been desirous to ascertain the depth of the marine waters which covered portions of the earth now become continents, and also to trace out the shores of the ancient ocean. She has succeeded in determining, by observation, these different points of fact, and that by a very simple means.

She has first endeavoured to ascertain if there was not, for each marine species, certain zones of depth which it never passed. The existence of these zones once established, she has applied to the ancient species the laws whose constancy had been determined in the distribution of analogous races.

By the aid of these facts, it has become possible to determine the extent of seas in the different geological epochs, and also to indicate, on charts of a new description, the points of their greatest depth, and even the contours of their coasts. These beaches, like the continents of which they formed a part, rose above the seas, in proportion as the latter subsided into the limits which they could not surpass.

The knowledge of these facts, for which we are indebted to the spirit of observation by which science is now directed, is one of those things of which in modern times we have most reason to be proud. It is perhaps as important, though less useful, than that which enables us to assign, with a remarkable degree of precision, the depth at which we may expect to meet with sheets of water sending forth spouting springs. Who of you, gentlemen, can forget that one of the most beautiful applications of a principle so simple and fruitful in results has been made in sinking the famous wells of Grenelle ?

Similar inductions are, in fact, scarcely possible, except in countries well known in their geological relations. It remains, therefore, to discover a means of supplying this method of appreciation ; it is a subject well worthy the attention and research of those who are interested in the progress of the useful and practical sciences (*See Note* 15).

Another peculiarity of the ancient world not less remarkable, and which relates to the epoch when seas were of much greater extent, is, that during this long interval fresh waters do not appear to have existed on the surface of the globe. At least the aquatic vegetables and animals of that period present no characters which can lead us to suppose that they inhabited waters not saline. It is not till after the separation of interior seas from the ocean, that we can, without hesitation, distinguish fresh water beings from marine species (*See Note* 16).

The vegetation of the early ages, luxuriant as it was, does not afford that almost infinite variety which characterises the present flora. If Man had existed at that time, it would have been vain for him to seek, by change of climate, or even of hemisphere, for those profound impressions which the numerous and varied trees of still virgin forests cause him to experience, by their immobility as much as by their size. He would have found everywhere a depressing uniformity, and would have seen, in the most different and remote countries, the same species reproduced, with the same forms and the same aspect.

The forests of the ancient world, independently of the monotony of their verdure, would have been still more painful to traverse from the circumstance that no voice could ever be heard in them to interrupt the silence or dissipate the gloom.

Do you ask if such a world could be made for us, and if we would not have been appalled at encountering in our fields lizards as large as whales, or beholding, flying in the air, dragons with murderous teeth, which, like Milton's Satan, might accomplish the most varied purposes? (*See Note* 17).

A characteristic difference in the vegetation of ancient times, was its want of variety compared with that which now adorns the surface of the earth. Thus, the flora of the epochs anterior to the appearance of Man, was composed of scarcely 2000 species, while we are now acquainted with more than 80,000, and probably upwards of 100,000 exist on the surface of the globe.

The same peculiarities are observed in regard to animals; and, to mention only one example, it may be stated that, instead of the 80,000 species of insects now contained in our collections, the fossiliferous strata of the ancient world afford us scarcely a thousand (*See Note* 18).

Do not suppose that the vegetables and animals met with in a fossil state belong to the same species as those living in the present day. Recent sedimentary formations are, in fact, the only ones in which we find species having such a degree of analogy to actual races that we cannot distinguish them. Setting aside these rare exceptions, the life of geological times, although constantly regulated by the same laws, has nothing in common with the new creation, as far as relates to its specific types (*See Note* 19).

As for the rest, it is not to be denied that Creative Power manifests itself as well in causing the ancient races to disappear as by the appearance of new beings, their destruction necessarily bringing forward others on the scene of life.

Neither suppose at the same time that, howsoever great the differences may appear to you between the old world and the new, the facts which were produced in the one are no longer reproduced in the other. Physical phenomena have fallen off only in their intensity and grandeur since Man set his foot on the globe. It may be said that at his approach the earth became tranquillized, and that disturbing phenomena by degrees lost their violence. Thus the upheavals which have produced great chains of mountains, such as the Pyrenees, the Alps, the Himalaya, and the chain of the Andes, have been reduced to such feeble proportions, that they confine themselves to casual elevations of the ground, of a few centimeters, and that not over the entire earth, but at a few insulated points.

Volcanoes—those safety-valves of the globe—have gradually diminished since geological times, when vegetation could dispense with the gases which they afforded it in the early ages. Volcanoes can scarcely now be regarded as formidable, except in the southern hemisphere; they have there indeed preserved something of their primitive magnitude in the long chain which runs almost throughout the entire extent of it. Earthquakes have likewise diminished, both in number and intensity—(*See Note* 20).

Perhaps the same thing has taken place with the auroræ boreales, those northern suns, whose brilliancy and splendour appear to be singularly impaired since climates have divided the earth into bands of equal mean temperature; and electricity, so intimately connected with heat, has been, like it, considerably diminished.

Lastly, fossiliferous beds—those catacombs in which lie buried the flora and fauna of anterior epochs, by means of which we are enabled to go backwards through the series of ages—have never ceased to be reproduced. Only in the present day they inclose the beings of historical times, instead of concealing in their bosom species, all of which have lived before the appearance of Man on the earth.

The beds of organic remains forming every day, differ from those of geological times only by their smaller extent, and also in the nature and species of the beings which they inclose —(*See Note* 21).

There is at the same time a phenomenon which seems to have undergone no variation from the most remote times; the constancy in the flow of mineral and thermal waters appears to have been always the same.

We have examined the principal differences between the ancient world and that which witnessed our arrival on the earth. Perhaps it might have been desirable to enter into longer illustrations of the collective phenomena submitted to your consideration; but we have not time to do this in a manner worthy of the subject. We shall account ourselves fortunate if we have caused you to feel an interest in the facts disclosed to you, and which are already so remote from us; for, as the priests of Sais said to Solon, We are but of yesterday on our aged earth. But the sciences count time and space as nothing; generations succeed each other and pass away, and with them the majestic edifice of human knowledge becomes enlarged. Have we not, then, reason to hope that the general laws of the principal phenomena of the globe, now better known, will soon give us the key to those which yet remain mysterious to us?

NOTE 1. The various modifications which the earth has undergone in geological times, and which have shaped the surface into the form we now witness, if considered in relation to us, are fearful revolutions. But, when viewed relatively to the earth itself, the elevation of the greatest chains of mountains is a phenomena of small importance; for the inequalities they have produced on it are more insignificant in regard to dimensions than those which cover the surface of an orange. These, however, were necessary, since the globe had to receive vegetables and animals, and required the means of producing running water. The destruction of a great number of organised bodies has been the consequence of the modifications to which the outline of the earth's surface has been subjected, and of the gradual sinking of the temperature. This diminution of temperature has produced new climates. Existing species are no longer threatened by the instability of the ancient climates, nor by difference in the composition of the atmosphere, which, like that of the seas, appears to have reached a state of remarkable fixity, a character belonging to all the phenomena of the present era.

NOTE 2. The atmosphere is now richer in oxygen than in geological times; this excess corresponds to the volume of carbonic acid which served for the nutrition of the plants of primitive ages. It corresponds also to the quantity of carbon and hydrogen contained in the carbonaceous remains left by ancient vegetables. The quantity of carbonic acid now existing in the atmosphere is not more than from four to six ten-thousand parts. To compensate for this trifling proportion of carbonic acid, some of it is continually escaping from the interior of the earth, as well as from volcanoes. Continental waters carry some of it along with them, and mineral and thermal waters exhale more or less considerable quantities of it. It is produced also at the expense of the carbonated hydrogen existing in the air, the decomposition of which takes place from the electrical discharges of the clouds, so frequent under the tropics.

NOTE 3. The greater extent of seas, at different geological epochs, is demonstrated by the marine organic remains which they have left in sedimentary formations. These remains are in general more remote from present seas as they belong to more ancient periods; it is the same with regard to their height above the level of the sea. Marine organic remains are referable principally to Zoophytes and Mollusks. They are distinguished into—1*st*, *pelagic* species, or such as have lived in deep seas; 2*dly*, others which have lived at a little distance from the shores; and lastly, such as lived only near the shore, and which on that account have been named *littoral*. The different zones relative to the depth of water at which the ancient Zoophytes and Mollusks lived, likewise exist in modern seas; each species is confined, by the conditions of its existence, to a determinate region.

NOTE 4. Large continents are so recent, that they only date from the most ancient tertiary formations, that is, from the period when interior seas became separated from the ocean. Continents were formed by degrees during a long series of successive upheavals and sinkings. Other facts confirm their tardy appearance, and prove that they were originally islands, and these islands of small extent. Primitive vegetation has been essentially composed of acrogenous cryptogamic vegetables, which now flourish only in the small islands of the equatorial zone. They are particularly abundant in those where the maritime climate has reached its maximum; accordingly these vegetables are characteristic of the transition and coal periods. The flora of the latter formations contained 250 species of ferns, while the whole of Europe affords scarcely 50 of them, that is 50 of the fossil species of this family. On the other hand, the gymnosperms do not exceed 25 species in Europe, while the flora of the coal formations has upwards of 120 of them, or nearly five times the amount. This flora, like that of the equatorial islands at present, contained few families; but such as existed in it had a greater number of species than the actual vegetable families. This ancient flora has left considerable masses of coal, and we can from that form an opinion of its vigour and beauty; it appears to have been tufted and luxuriant, like that of warm and humid islands. On the other hand, the arborescent flora of the coal period indicates a vegetation almost entirely terrestrial. It presents, in the last place, as an essential character, in every part of the globe where it has been met with, the most remarkable organic identity—a proof of the uniformity of temperature which then everywhere prevailed.

NOTE 5. We may form an idea of the quantity of carbonic acid which existed in the atmosphere of ancient times, by referring to the observations of Theodore de Saussure. This skilful natural philosopher has proved that from six to eight hundred parts of carbonic acid disseminated in the air rendered vegetation peculiarly vigorous, but that, when this proportion was considerably exceeded, the plants subjected to its influence rather quickly perished. If then the quantity of 6 or 8 per cent. existed in the atmosphere of ancient times, it would be a hundred times greater than the proportion now met with. Indeed, the proportion of carbonic acid in the atmosphere is now so inconsiderable, that it appears not to exceed from four to six ten thousand parts of its volume. Volcanic countries, and particularly the vicinity of Naples, are celebrated for their fertility just on account of the quantity of carbonic acid which is everywhere exhaled from the ground. The Grotte-du-chien is the locality where this exhalation is most abundant in Italy.

NOTE 6. We know, from M. Gœppert's observations on the flora of amber, that the trees which produce this fossil resin occupied an immense area in northern countries, and probably extended to the polar regions of the globe. We now find nothing, in the same places, but mountains of ice. It is not necessary to suppose that the trees were of small dimensions; for they belonged chiefly to these families Abietineæ and Cupressineæ, which contain the largest vegetables of the coniferous order. The articles published in these Journals in December 1853, on the discovery made by Captain MacClure of a district in the North Seas, all go to confirm these facts, affording us a new example of the vigorous vegetation which prevailed in geological times near the Poles. At a little distance from Baring Land, (which is only at the southern extremity of that named Banks, the latter separated from Melville Island by an arm of the sea,) this intrepid navigator found, at about 500 feet above the level of the sea, a range of hills composed of a mass of wood in all states, from complete petrifaction to that of inflammable chips. He likewise observed a large species of bivalve shell of the size of an oyster. These facts are remarkable, inasmuch as they indicate a vigorous vegetation in geological epochs in regions now covered with ice, and where the largest tree is the dwarf willow. We know that the trunk of this miniature willow is scarcely thicker than an ordinary pipe. Certainly these woods and shells do not belong to the actual flora or fauna of these regions, as Captain MacClure himself remarks; neither can they be regarded as proofs of a deluge, for they are greatly anterior to the dispersion of diluvial deposits.

NOTE 7. The greater part of fossil species, embedded in the polar regions as well as everywhere else, are allied rather to the species of tropical countries than to those of temperate ones. This circumstance proves that the temperature must have been more elevated and at the same time more uniform, at the time when these beings lived, than it is now.

NOTE 8. The calorific rays of the sun do not penetrate below 28 or 30 metres of the solid beds. At this point the temperature is uniform, and nearly constant at all seasons. If the earth did not receive any other heat than that which it derives from the Sun or other stars, this heat ought to diminish below the invariable bed. Now, instead of diminishing, it increases in proportion as we penetrate into the earth's strata, which proves that the globe must have a temperature of its own. An objection, more specious than solid, has been opposed to this hypothesis. How can we judge of this increase, it is said, from a depth so inconsiderable as that of about 700 metres below which thermometers have been carried, and thence conclude that the temperature of the earth increases in a constant manner from the circumference to the centre? No doubt this depth is nothing when we think of the earth's radius; but volcanic fires, thermal waters, and the increase of heat which is evident wherever we descend below the invariable bed of 28 or 30 metres, are sufficient to show that the supposition is far from being without support.

NOTE 9. The influence of the figure and form of the terrestrial globe is as perceptible on the physical phenomena which take place at its surface, as on the migrations of its people, their laws, manners, and all the principal historical facts of which it has been the theatre. With regard to the primitive liquidity of the earth, proved by the form it has taken, it cannot be attributed to water; the existing quantity is much too small to have ever produced such an effect. That quantity scarcely amounts to the fiftieth-thousand part of the solid portion. Now as a liquid, whatever be its temperature, cannot dissolve a quantity of solid matter superior to it in weight, it follows that the terrestrial waters could not dissolve the entire materials composing the whole globe. We must therefore have recourse to another cause. Among those whose action has been manifested in a great number of phenomena, only one can produce such an effect. That cause is heat, as indicated by the composition of the portion of the earth known to us. It also follows from this, that the principal part of our globe presents not the least trace of organic remains, and is composed of rocks which are produced only under the influence of a high temperature.

Note 10. M. Biot's observations on the twilight, have proved that the height which has been rashly named as the limit of the atmosphere is much too great. As luminous phenomena may be produced independently of oxygen, Poisson inclined to believe that aerolites became inflamed much beyond the last gaseous strata of our atmosphere. But this department of science, like that occupied with the larger bodies composing the solar system, presents no solid foundation for our reasonings and researches, but that to which calculations and geometrical measurements can be applied. In like manner the atmosphere of the sun is confined, as M. de Humboldt has observed, to much more restricted limits than those to which the zodiacal light extends.

Note 11. Fourier, the inventor of the theory of heat, has inferred from the whole of his researches, that the temperature of the interplanetary spaces was about 60 degrees below zero. M. Liais, desirous to verify the observations made before his time, has found it necessary to lower still further the figure given by Fourier, and that the heat of these spaces approached to — 100°. Observations have been always found to agree with the hypothesis of a very low temperature. Thus MM. Barral and Bixio observed, in the ascent they made from Paris on 27th July 1850, that the barometer was at 0m,33805, and their thermometer sunk to — 35° and even to — 39° 67, when they reached a height of 6512 metres. On the other hand, during a voyage undertaken in search of Captain Ross in the Icy Sea, the thermometer fell below — 56° 6, which may afford us an idea of the low temperature of the interplanetary spaces.

Note 12. We cannot cast our eyes on the crust of our globe, without observing marks of a destroyed organic world. The sedimentary rocks present a succession of organized beings, associated in groups, the greater part of which have disappeared and been replaced by others. As this phenomenon is renewed at many intervals, the superimposed beds, from one to another, reveal to us the fauna and flora of different epochs. A profusion of organic forms has predominated, at all periods of the earth, in the basin of the ocean; it is there that life has had its chief abode both in the ancient and modern world. The infusorial fossils of the cretaceous formations and of the fresh water tertiary, show us the immense development life had acquired in these ancient epochs. Thus, the tripoli of the last formations is almost entirely composed of the skeletons or carapaces of microscopic animals. M. Ehrenberg calculates that each cubic inch of this substance, weighing about 220 grains, contains forty thousand millions of *Gallionella distans*, which gives about 187 millions to a grain. At each friction of the stone, therefore, many millions, perhaps ten millions of entire fossils, are reduced to powder or atoms. On the other hand, the sand of the Antilles contains more than 3,840,000 infusoria in 30 grammes. The dust we trample under our feet is also filled with these infinitesimal minutiæ; it is the same with the ice of the pole. Still further; the meteoric dusts brought from great distances from the coasts, for example 380 marine miles, are also of organic origin. They are composed in great part of microscopic infusoria. There is likewise developed, in regions where large organisms cannot exist, a kind of life infinitely minute, almost invisible, but incessant. It prevails in the eternal night of oceanic depths; while vegetable life, stimulated by the periodical action of the solar rays, is largely diffused over continents where the mass of vegetables is incomparably greater than that of animals.

NOTE 13. The strata of the earth not only inclose marine organic remains, but also afford numerous traces of terrestrial species. The fresh water races, as well as those of salt waters, have in general succeeded each other in the direct ratio of the complication of organization, the most simple before the most complicated. At the same time, the relations between the age of formations and the physiological gradation of the species they inclose, does not appear in a regular manner except in the most complicated vegetables, such as the gymnosperms, monocotyledons, and dicotyledons. The same thing takes place with animals: the vertebrates are striking examples of it. Their classes, and to a certain point their families, follow each other and have appeared, according to the most general law of the ancient creations. On the other hand, the acrogenous cryptogams, which formed part of the earliest vegetation, have entered upon the scene of the world in all their perfection; such has likewise been the case with the cephalopod molluscs. But these vegetables and animals form part of the least complicated class of the branches to which they belong. They do not the less prove that the perfection of organization which has followed the order of time, has operated among the superior divisions, such as classes, rather than among orders and families. Nature seems to have arrived at the production of the most perfect vegetables and animals only by a series of trials, or, if we may so express it, successive attempts. Thus the didelphous mammifera, the least complicated of their class, have appeared long before the monodelphes, which exhibit the maximum of perfection in organism; the latter have gone through many generations, and have seen many of their species perish, before becoming the contemporaries of Man, the most perfect being in creation.

NOTE 14. Interior reactions have given its form to the surface of the globe, by raising chains of mountains through strata much inclined. These reactions have prepared the field where the forces of organic life must have begun to operate after the return of tranquillity, in order to develop there the profusion of individual forms. These conspicuous upheavals have in a great measure done away, in both hemispheres, with that uniformity of level which, had it continued, would have rendered the globe uninhabitable. The most influential cause in the formation of mountains has, doubtless, been the raising up of the ground, whether it took place from the expansion of elastic fluids, or was produced by some other action. But these causes have not acted alone. Others, though less powerful, have also modified the relief of the earth's surface, and given it the form which now meets our eyes and invites our observation.

Note 15. M. Hericart de Theury thought that waters ready to burst forth might be found, at Grenelle, in the lower beds of the chalk, and that, as they would be fed by the same aquiferous reservoirs found at Rouen and Tours, they would be met with at a depth of 560 or 575 metres. He estimated, moreover, before the wells at Grenelle were sunk, that the waters would spout out at 15 or 20 metres below the surface, and that they would be abundant and of good quality. These predictions of M. Hericart de Theury were verified almost to the letter; instead of being obliged to dig to 560 metres, the sheet of water was found at 547. It has furnished spouting springs which, when the probe-hole was furnished with a tube, rose to a height of nearly 30 metres. On the other hand, Mr Walferdin had calculated that the aquiferous sheet was to be found in the neighbourhood of Tours, at 125 or 130 metres below the level of the sea, and that the waters would be ejected at Grenelle when the probe should reach the corresponding sheet. This calculation is as well verified as M. Hericart de Theury's predictions.

Note 16. The Portland deposits, which belong to the secondary epoch, are the earliest formations in which animal species were discovered whose analogues now live in fresh or salt waters; both have the closest affinity, not in regard to their specific relations, but in their generic characters, to living races. It is only in the time of the tertiary deposits that the distinction of fresh and salt water species becomes decided, and when the lacustrine formations have covered spaces of pretty considerable extent. Before the Portland and Wealden formations, the nature of the deposits, and even the organization of vegetables and animals, present no character which enables us to recognise differences in the waters where the one or the other lived.

Note 17. When we say that there existed, in geological times, lizards as large as whales, we do not mean to compare these animals in regard to bulk, but only in respect to their length. We could not, in fact, establish a comparison between them, and place them beside each other in the first point of view, as will readily be seen when we consider that most lizards are provided with a tail, whose length equals that of their body, and that this part never acquires a great breadth, and consequently a volume, above certain dimensions.

Note 18. According to the enumeration we have given, the ancient vegetation was only a fiftieth, or at most the fortieth, of the *present vegetation*. The former appears to have acquired, in Europe, more considerable proportions than anywhere else; it was, in fact, the twentieth part of the flora of this country. This relation continues nearly the same when we compare the flora of well determined formations, as, for example, that of the coal and transition formations. It comprehends 500 species, while Europe possesses nearly 12,000 living plants. Even though the flora of the ancient world should be the twentieth part of that which now adorns the earth, it would have been much inferior to the existing vegetation in regard to the variety of its species. The flora of amber, compared with that of Germany, although it occupied a much more considerable extent, yet gives us a smaller figure than the whole of the two vegetations. According to the last edition of Kocks (1851), the flora of Germany comprehends 6802 cryptogamous, 3454 phanerogamous species, amounting together to 10,256 species. The number of vegetables hitherto observed in the various amber deposits does not exceed 162. This flora was, therefore, 63 times less considerable than the former. In truth, all the vegetables of the ancient world have not reached our times, and we are far from being acquainted with the whole of the fossil species; but making a large allowance for these circumstances, and reducing the relative number given by observation to a fortieth part, one of these floras would be still much more varied than the other. The same facts ought to appear among animals, since even those supported by flesh and living prey feed on herbivorous species. Two examples will be sufficient to prove the small number of the ancient animal races, compared with those living at the present time. We shall take them from the classes best known; for example, the fishes. Eighteen hundred species appear to have existed in the old world, while about 9000 have been enumerated belonging to our own epoch, a relation which is : : 1 : 5. This relation, superior to that presented by vegetables, is probably owing to this, that the study of fossil fishes is perhaps more advanced that that of the living species. It is entirely different with the insects of the ancient world; not more, at least, have been observed up to the present time than about 1000 species, while the number of living races already amounts to 80,000. However considerable this number may appear, it is still short of that which calculations, seemingly well founded, attribute to the species of our world. The latter is no less than 362,000, of which 282,000 remain to be discovered. Entomologists have, therefore, much to do in order to fill up this blank.

Note 19. It is only in recent sedimentary deposits that we find species like those now living. This identity between a small number of the species of geological times and our own, admitted by English and Italian geologists, is however denied by some French naturalists. In order to determine on which side the truth lies, we have undertaken a work with the intention of definitely settling this question. This work is sufficiently advanced to enable us certainly to affirm that the number of analogous races is extremely restricted, but that many exist, (principally among animals), which we cannot help regarding as identical with our own. It appears to be the same with vegetables.

NOTE 20. Active volcanoes are true safety-valves for the adjacent regions. It is the same with thermal waters. If the opening of a volcano has been closed, and the communication with the atmosphere interrupted, the neighbouring countries are threatened with shocks. We may well suppose that there exist, in the interior of the earth, a source of electro-magnetic currents, polar auroræ, and irregular movements which disturb its surface.

NOTE 21. Not only do the great phenomena which took place during geological times still occur in the present day, but it is the same with those which, by being on a smaller scale, are less fitted to arrest our attention. Thus the fall of stones or meteoric masses is constantly perpetuated on the surface of the globe; they are discovered as well in the interior strata as on the surface of the earth. The phenomenon of aerolites is not peculiar to our epoch, since fossil ones exist; it is continued from geological times to our own day. On the other hand, the petrifaction of organized bodies is not confined to times anterior to our own epoch; it is taking place to-day both in fresh water and in salt. We have ourselves proved that vegetables petrify in the former, just as the remains of molluscs or shells do in the latter. If we are not certain that the same thing takes place with bones, it is probably because we have not been placed in circumstances favourable to the discovery of them in that state. It is not at least to be supposed, that wood, grains, shells, and the tubes of the annelides, should be capable of passing into a stony state, and that it should not be the same with osseous remains charged with calcareous matter, and already in a solid condition. In consequence of this peculiarity in a great number of organic remains, of being capable of being replaced by an inorganic matter more solid than that of which they were first composed, sandstones and beds of shells are forming every day on the beaches of existing seas; these beds have the closest analogy to the shell-banks of the tertiary epoch.

Observations on the Gradual Changes that the Human Races appear destined to pass through.

Nature marches steadily towards perfection; and it attains this end through the consecutive destruction of living beings. Geology and palæontology prove a succession of creations and destructions prior to any effacements of man; and it is contended by Hombron and other naturalists, that the inferior races of mankind were created before the superior types, who now appear destined to supplant their predecessors. Albeit, whatever may have been the order of creation, the unintellectual races seem doomed to eventual disappearance in all those climates where the higher groups of fair-skinned families can permanently exist.

The entire race of the Guanches, at the Canary Islands, was exterminated by the Portuguese during the thirteenth and fourteenth centuries; not a living vestige remaining to tell the tale. Some of the pre-Celtic inhabitants of Britain, Gaul, and Scandinavia, seem to have shared a similar fate; 16,000,000 of aborigines in North America have dwindled down to 2,000,000 since the "Mayflower" discharged on Plymouth Rock; and their congeners, the Caribs, have long been extinct in the West Indian Islands. The mortal destiny of the whole American group is already perceived to be running out, like the sand in Time's hour-glass. Of 400,000 inhabitants of the Sandwich Islands, far less than 100,000 survive, and these are daily sinking beneath civilization, missionaries, and rum. In New Holland, New Guinea, many of the Pacific Islands, and other parts of the world, the same work of destruction is going on; and the colours of proselytism are vain, save to hasten its accomplishment.

"Pourquoi cela?" asks Bodichon. "*It is because their social state is a perpetual strife against humanity.* Thus, murder, depredations, incessant useless strifes of one against another, are their natural state. They practise human sacrifices and mutilations of man; they are imbued with hostility and antipathy towards all not of their race. They maintain polygamy, slavery, and submit women to labour incompatible with female organization.

"In the eyes of theology they are lost men; in the eyes of morality vicious men; in the eyes of humanitary economy they are non-producers. From their origin they have not recognized, and still refuse to recognize, a supreme law imposed by the Almighty, viz., the *obligation of labour*.

"On the other hand, all nations of the earth have made war upon the Jews in 4000 years; the Egyptians, the Assyrians, the Greeks, the Romans, &c.,—Christians and Mohammedans by turns; with innumerable cruelties, physical and moral; nevertheless, that race lives and prospers. Why? Because they have everywhere played their part in the progress of civilization.

"True philanthropy (asserts Bodichon) should not tolerate the existence of a race whose naturality is opposed to progress, and who constantly struggle against the general rights and interests of humanity. Omnipotence has provided for the renovation of manhood in countries where effeminacy has prostrated human energies. Earth has its tempests as well as the ocean. There are reserved, without doubt, in the destinies of nations, fearful epochs in the ravage of human races; and there are times marked on the Divine calendar for the ruin of empires, and for the periodical renewal of the mundane features."

"In the midst of this crash of empires (says the Philosophical Virez), which rise and fall on every side, immutable Nature holds the balance, and presides, ever dispassionately, over such events, which are but the re-establishment of equilibrium in the systems of organized beings."—(*Nott and Gliddon on the Types of Mankind.*)

On the Probable Direful Consequences from the Intermingling of Human Races.

It is *mind*, and mind alone, which constitutes the proudest prerogative of man, whose excellence should be measured by his intelligence and virtue. The negro and other unintellectual types have been shown to possess heads much smaller, by actual measurement in cubic inches, than the white races; and although a metaphysician may dispute about the causes which may have debased their intellects, or precluded their expansion, it cannot be denied that these dark races are greatly inferior to the others of fairer complexion. Now, when the white and black races are crossed together, the offspring exhibits throughout a modified anatomical structure, associated with sundry characteristics of an intermediate type. Among other changes superinduced, the head of a mulatto is larger than that of the negro, the forehead is more developed, the facial angle enlarged, and the intellect becomes manifestly improved. This fact is notorious, viz., that the mulattoes, although but a fraction of the population of Hayti, had ruled the island till expelled by the overwhelming jealousy and major numerical force of the blacks. In Liberia, President Roberts boasts of but one-fourth negro-blood; while all the coloured chiefs of departments in that infant republic hold in their veins more or less of white blood; which component had been copiously infiltrated prior to emigration from America into that population generally. If all the white blood were suddenly abstracted, or the flow of whitening elements from the United States to be stopped, the whole fabric would doubtless soon fall into ruins, and leave as little trace behind as Herodotus's famous negro colony of Colchis, or the more historical one of Meroë. From the best information procurable, we know that there has been a vast deal of exaggeration among colonizationists at home about this mulatto colony of Liberia abroad; nor, much as we should be gratified at the success of the experiment, can we perceive how any durable good can be expected from it, unless some process be discovered by which a negro can be highly cultivated mentally. History affords no evidence that cultivation, or any known causes but physical amalgamation, can alter a primitive conformation in the slightest degree. Loyele himself acknowledges :—"The separation of the coloured children in the Boston schools arose, not from an indulgence in anti-negro feelings, but because they find they can in this way bring on both races faster. Up to the age of fourteen the black children advance as fast as the whites; but after that age, unless there be an admixture of white blood, it becomes in most instances extremely difficult to carry them forward. That the half-breeds should be intermediate between the two parent stocks, and that the coloured should therefore gain in mental capacity in proportion as it approximates in physical organization to the whites, seems natural; and yet it is a wonderful fact, psychologically considered, that we should be able to trace the phenomena of hybridity even into the world of intellect and reason." Dark-skinned races, history attests, are only fit for military governments. It is the unique rule genial to their physical nature. None but the fair-skinned types of mankind have been able hitherto to realize, in peaceful practice, the old Germanic system described by Tacitus :—"De minoribus rebus principes consultant de majoribus omnes;" *omnes*, be it understood, signifying exclusively white men of their own type.

The races of mankind obey the same organic laws which govern other animals; they have their geographical points of origin, and are adapted to certain external conditions that cannot be changed with impunity. The natives of one zone cannot always be transferred to another without deteriorating physically and mentally. Races, too, are governed by certain psychological influences, which differ among the species of mankind, as instincts vary among the species of lower animals. These psychological characteristics form part of the great mysteries of human nature. They seem often to work in opposition to the physical necessities of races, and to drive individuals and nations beyond the confines of human reason. We see around us, daily, individuals obeying blindly their psychological instincts; and one nation reads of the causes which have led to the decline and fall of other empires without profiting by the lesson.

The laws of God operate not through a few thousand years, but through eternity, and we cannot always perceive the why or wherefore of what passes in our brief day. Nations and races, like individuals, have each an especial destiny; some are born to rule, and others to be ruled—and such has ever been the history of mankind—*no two distinctly marked races can dwell together on equal terms.* Some races, moreover, appear destined to live and prosper for a time, until the destroying race comes, which is to exterminate and supplant them. The Caucasian race is destined eventually to conquer, and hold every foot of the globe where climate does not interpose an impenetrable barrier.

No philanthropy, no legislation, no missionary labours, can change this law; it is written in man's nature by the hand of his Creator.

If these remarks are correct, it is evident that the superior races ought to be kept free from all adulteration, otherwise the world will undoubtedly retrograde instead of advance.—(*Dr J. C. Nott and G. R. Gliddon on the Types of Mankind*).

The Primitive Diversity and Number of Animals in Geological Times. By L. AGASSIZ, Professor of Zoology and Geology in the Lawrence University, at Cambridge, Massachusetts.

The facts and data in this sound, philosophical, and analytical paper of Professor Agassiz, in a great measure disproves the notion entertained by naturalists and geologists, that genera and species of animals and plants are greatly more numerous at the present age of the world than in any previous geological period; and this he clearly shows holds good in the distribution of the animal and vegetable kingdoms throughout the earth's orbit, with one or two exceptions. A mere chronological list of fossils is to him of very little importance, in comparison to a good typographical description of the species. He shows the necessity of acquiring a knowledge not only of the general biological character of the epoch, but also of the local fauna of each period. Agassiz states that our present list of fossils teem with chronological errors of the worst kind, arising from false identifications of strata. This we can well imagine, because our mineralogical, (geologically speaking) stratigraphical, and petralogical knowledge are extremely vague. Agassiz further shows in this paper that the number of false identifications of organic remains that have accumulated in zoological works are truly frightful; and he maintains that the materials thus accumulated are no longer fit to be used in the discussion of the questions that have been raised with the modern professors of geology, and that a thorough revision of all the identifications of species is required,—and shows that without a complete knowledge of species, it is a hopeless task to attempt to determine the order of succession of the fossils in different geological formations.

He concludes this valuable paper with important remarks on the disputed question of the period of appearance of dicotyledonous plants in the geological science. He maintains that the dicotyledoneæ are inferior to the monocotyledoneæ, and that there exists a similar gradation of types in the vegetable as in the animal kingdoms.

There is a view generally entertained by naturalists and geologists that genera and species of animals and plants are greatly more numerous at the present age of the world than in any previous geological period. This seems to me an entire misconception of the character and diversity of the fossils which have been discovered in the different geological formations, and to rest upon estimates which are not made within the same limits, and with the same standard. Whenever a comparison of the diversity and number of fossils of any geological period has been made with those of the living animals and plants belonging to the same classes and families, it has been done under the tacit assumption which seems to me entirely unjustifiable, that the fossils formerly inhabiting our globe are known to the same extent as the animals which live at present upon its surface; while it should be well *understood* that however accurate our knowledge of fossils may be, it has been restricted, for each geological formation, to a few circumscribed areas. Comparisons of fossils with the living animals ought, therefore, to be limited to geographical districts corresponding in extent to those in which the fossils occur; or, more properly, a fossil fauna with all its local pecularities ought to be compared with a *corresponding* fauna of the present period, and not with *all* the animals of the same class living at present *upon the whole surface* of the globe. And when this is done with sufficient care, and proper allowance is made for the limited time during which investigations of fossils have been traced compared with that which has been almost everywhere devoted to the closer study of living animals, it will be seen that the number and diversity of species peculiar to each special fossil fauna is, in most instances, equal to those found to characterize zoological provinces of similar boundaries at the present day. And this may be said of the fossil faunæ of all ages. In many instances the result is even quite the reverse of what is generally supposed to be the fact, for there are distinct fossil faunæ which have yielded much larger numbers of species, presenting a greater variety of types than any corresponding fauna in the present age. Some examples will justify this perhaps unexpected statement.

The number of species of shells which are found living along the shores of Europe, does not exceed six hundred. About six hundred species is again the number assigned to the whole basin of the Mediterranean, including both the European and African coasts. Now the most superficial comparison between them and the fossil species which occur in the lower tertiary beds in the vicinity of Paris, shows the latter to exceed twice that number; there are indeed twelve hundred species of fossil shells now known from the eocene beds in the immediate vicinity of Paris, affording at once a very striking evidence of the greater diversity and greater number of species of that geological period when compared even with those of a wider geographical area at the present day.

If it be objected that the variety of forms which occur in tropical faunæ is greater than that which we observe on the shores of our temperate regions, and that the temperature of the tertiary period having been warmer, we may expect a larger number of fossil species from those deposits, I would only refer to local enumerations of marine shells from several tropical regions, to sustain my assertion that the number of fossil shells of the eocene beds of the *immediate vicinity of Paris* is much greater than that of any local fauna of the present period, even within the tropics. A catalogue of not quite three hundred species of shells, given by Dufo, as occurring around the Sechelles Islands, the extent of which may fairly be compared with that of the lower tertiary beds around Paris, will suffice to show, that in a tropical local fauna the number of species known to exist in the present day is far inferior to the number of species known to have occurred during the deposition of the lower tertiary beds in the vicinity of Paris. Another catalogue by Sganzin, of the shells found about Mauritius, Bourbon, and Madagascar, gives also less than three hundred species for that extensive range of seas surrounding those islands. Let us further compare the results of the investigations of the shells of the Red Sea by Hemprich, Ehrenberg, and Rüppel, and there again we find a smaller number, and a more limited variety of types than are found in the tertiary of Paris; for the whole basin of the Red Sea has thus far yielded only 400 species of shells. Let us finally take the most accurate survey of this kind we have of any shore—that of Panama by Professor Adams, extending over 50° of latitude, 28° N. of the equator, and 22° S. of it, including the most favourable localities for the growth of shells in the Pacific under the tropics, and yet we shall find this list exceeding but little the number of 500 species. In this instance, again, we find that the advantage in number and variety is in favour of the tertiary period, and not of the present age. If a different result has been obtained by the estimates made before this, it is owing to the circumstance, that the *fossils known from a few localities within narrow geographical limits* were compared with the *living species known to occur upon the whole surface of the globe.* But let us trace these comparisons through other geological periods, with reference to other classes also, and we shall find, in every instance, similar results. The tertiary fossils of Bordeaux, though less numerous in species than those of the eocene in the vicinity of Paris, will compare with any local fauna of the present period as favourably for variety and number of species as those of the lower tertiaries. This may be said, with the same certainty, of the tertiary shells of the Sub-Apennine Hills, or of those of the English Crag, of which we now possess a very complete list.

If from the tertiary periods we pass down to the cretaceous, do we not find in the deposits of Mæstricht, or in those of the age of the white chalk, a number and variety of shells as great as that which may be found on any shore or in any circumscribed marine basin of an extent at all comparable with that of the cretraeous beds within similar limits? Do we not find in the lower cretaceous strata, such as the green sand or the Neocomien, other assemblages of the remains of Mollusks, which, in number and variety, are not inferior to those of the white chalk? The oolitic series, again, will stand a similar comparison quite as well. We need not even take the whole group of those deposits, but consider each subdivision of the Jurassic period by itself, and still we find in every one local faunæ of Mollusks, assuming of course a different character from those of the cretaceous or tertiary, but nevertheless sufficiently diversified to admit of an estimate as advantageous with respect to the points under consideration, and to the local faunæ of the present day, as to the cretaceous assemblages of fossils, or those of the tertiary period. Of course, in accordance with the peculiar character of the age, different families prevail in these different periods; the Cephalopoda are extremely numerous and surprisingly diversified during the cretaceous and oolitic periods; while they dwindle down to a few representatives in the tertiaries, and so with other families. The shells found in the deposits of the new red sandstone period, of the coal period, and of the still earlier ages, are perhaps less numerous on the whole, though they can hardly be said to be less diversified; for the extinct forms which occur among them are quite an equivalent to the variety of their families which have lived during more recent periods; and the daily increase of the species found in the different palæozoic deposits show that, even in point of numbers those ancient faunæ may, even in the present state of our knowledge, be compared with local faunæ of similar extent at the present day.

Desirous of making the most accurate comparison possible between the *subdivisions* of the palæozoic formations of the state of New York with *local faunæ of similar extent* in the present seas, I have requested Professor J. Hall to furnish me with summary indications respecting the results of his extensive investigations in this field, and I have obtained from him the following statement :—

"I regard the *Potsdam and Calciferous Sandstone* as disconnected with the groups above, forming of themselves with their fauna (not yet well known in this country) a distinct geological period. The entire number of species thus far known in these rocks, admitting all of Owen's species, is however only twenty-six.

"The *Chazy Limestone* has 45 species restricted to itself, and one other species which is also known in the Black River Limestone. The *Birdseye Limestone* has 19 species restricted to itself, and two others which pass upwards. The *Black River Limestone* has 13 species restricted to itself, and one common to it and the Chazy limestone, one common to it and Birdseye, and one common to it and the Trenton, and one other which is common to the beds below and above, extending into the Hudson River group," making together 81 species for these three sets of beds.

"The *Trenton Limestone* has 188 species restricted to itself, and 30 species passing upwards into the Hudson River group. The entire number of species known as occurring in the Trenton Limestone, including those which occur in rocks above and below, is about 230. This statement includes some species discovered since the publication of the 1st volume of the Palæontology of New York, and which would make the restricted species about 200.

"The *Hudson River Group*, including Utica slate, has about 60 restricted species, besides those which are common to it and the rocks below, making altogether about 100 species.

"You will observe that the development of life at the Trenton period has been far the most marked, though it is true that this formation is much thicker than either of the preceding limestones, the Chazy being the thickest, and the Black River the thinnest, of the three below the Trenton.

"In that portion of the upper Silurian period included in the 2d volume of the Palæontology of New York, the fossils of the Medina Sandstone, Clinton group, Niagara and Onondaga Salt groups, amount to 341. *Medina and Clinton groups* 123 species, *Niagara and Onondaga Salt group* 218 species.

"The Medina Sandstone and arenaceous beds of the Clinton group contain 50 species, which, added to the 218 species of the Niagara and Onondaga Salt groups, give 291 species as the total number of species of the calcareous beds of these groups. The Niagara is here the more important period, and though not thicker than either of the others, contains about 200 species restricted to itself. Of the Niagara group 67 species are Corals and Bryozoa. Of the 73 species from the calcareous beds of the Clinton group, 19 are Corals and Bryozoa.

"In the *lower Helderberg group*, including the Waterlime, Pentamerous limestone, Delthyris Shaly limestone, and upper Pentamerous limestone, I expect to describe about 200 species, exclusive of Corals and Bryozoa, of which I know already about fifty species.

"The *Oriskany Sandstone* may contain about 60 species of fossils altogether, perhaps less.

"In the *upper Helderberg group*, which is the next great Calcareous formation, I anticipate a less number of species, except Corals and Bryozoa, of which there are more than 100 species in New York and the western localities. Of all that is yet known in these limestones, besides Corals and Bryozoa, it would be unsafe for me to estimate more than 100 species.

"From the *Hamilton*, *Portage*, and *Chemung groups*, I anticipate at least 300 species within New York, and I shall not be surprised if more complete investigations produce double that number in New York and the West.

"The number of species given here I regard as only approximate. I hope this general statement may meet your present requirement, but I regret that I cannot now give you more definite information, particularly regarding the Upper Helderberg. I give you from this and the higher groups an estimate based on the species known to me at the present time; but my final investigations always reveal a greater number than I anticipate."

These statements of Professor Hall place already each of the principal group of rocks of the state of New York in the category of distinct independent successive faunæ, equivalent each to as many local faunæ of the present period, for we may repeat that the fauna of the Sechelles contains only 258 species, and that of Mauritius, Bourbon, and Madagascar, 275. Nay, upon 3000 miles of coast along the western shores of the American continent, within the tropics, only twice the number of living species have been obtained as occur respectively in each successive greater subdivision of the palæozoic system within the narrow limits of the state of New York only.—(See above the results of Professor Adams's investigations upon the coast of Panama).

It is a most unexpected and very significant coincidence that the late admirable investigations of Elie de Beaumont upon the mountain systems have led him to the recognition of nearly ten times as many periods of great disturbance in the physical constitution of the earth's surface as he himself knew twenty-five years ago, each attended by the upheaval of as many mountain chains, differing in their main direction. The investigations of palæontologists having an entirely different character, and founded upon facts which until recently have apparently had only a remote connection with the other series of phenomena, have nevertheless brought them at about the same time to like conclusions respecting animal life, showing that the periods of disappearance and renovation of organized beings upon earth have been much more frequent than could be supposed even ten years ago, each set having probably been characteristic of one of those long periods of comparative rest, intervening between two great successive geological cataclysms.

What is true of Mollusca, may be said of all other classes.

Among Radiata, are not the coral reefs of the palæozoic ages as rich in species as any coral reef of the Pacific? Let us even compare the most extensive list of corals yet given as belonging to any circumscribed locality,—those of the Red Sea as described by Ehrenberg,—those of the Feejee Islands as described by Professor J. D. Dana,—and let us inquire whether the palæozoic rocks of the state of New York do not show as great a variety and as large a number of species in their successive reefs. Again, the coral reefs of the oolitic period in Normandy, or in the Jura of Switzerland, and the Alp of Wurtemberg, have they not increased our lists of fossils as largely, and introduced into our zoological works as various forms as are known from any of the most diversified coral regions in the world at the present day?

Passing from the Corals to the Echinoderms, the question may be reversed, and it may be fairly asked whether there is any sea shore extending over tens and tens of degrees of longitude and latitude, even under the tropics, which has yielded as large a number of those Radiata, as occur in almost any of the geological formations? The number of Crinoids found in the single set of beds known under the name of Niagara limestone, equals the whole number of Echinoderms found around all the coast of the United States. The Crinoids, Echini, and Star-fishes of the oolitic period, or any of the subdivisions of that formation, surpass the number of species of that class which may be gathered around the coast of entire continents in the present day. The diversity of forms of these animals, comparing them with those of the cretaceous periods, is equally great, though the Crinoids begin to diminish in number. But the variety of Spatangoids and Clypeastroids which come into play, compensate largely for the diminution of the family of Crinoids.

The type of Articulata may seem, in the present condition of our knowledge, to form an unanswerable objection to the broad statement I have made above, for the hundred thousands of insects which are known in the present creation will hardly allow a comparison with the fossils. But let us examine, upon the principles by which we have been guided in the preceding computations, which is the true state of things respecting the occurrence of Articulata in former geological periods. We can, of course, hardly expect to find worms well preserved in geological formations, on account of the softness of their body, which will scarcely allow of preservation to a greater degree than Medusæ. But a few instances in which impressions of these animals have been found justifies the assertion that they existed as well in former periods as now. The impressions of Medusæ found in the lithographic limestone of Solenhofen, which are preserved in the Museum of Carlsruhe, not only carry back the existence of this class to the Jurassic period, but justify the question whether a large number of the fossil polypi from older periods, which have been described as belonging to that class, are not in reality nurses of Medusæ similar to the Campanulariæ and Sertulariæ of the present day, which are now known to be no Polyps, but one of the alternate generations of Medusæ. And as for the worms, we find in each geological formation, from the oldest to the most recent, fossil Serpulæ, or similar solid cases of worms in as large numbers as we find these animals anywhere at the present day. And where the existence of Serpulæ is established by such unquestionable evidence as that of their calcareous cases, are we not justified in the inference that those entirely naked worms, which are found everywhere existing with Serpulæ, had also their corresponding representatives during former geological periods?

With the class of Crustacea the difficulty in the comparison is already less; for, in the tertiary beds of Sheppy there have been found a variety of lobsters, shrimps, and crabs, which would favourably compare with the crab fauna of any limited shore in the present day; and I doubt very much whether such a variety of Crustacea could be collected anywhere on a shore of equal extent to that of the white chalk of Sussex, as Dr Mantel has uncovered in the vicinity of Lewes. For a comparison of the Crustacea of the oolitic period, I would only refer the sceptic to the monograph of the Crustacea of Solenhofen by Count Münster, who has figured from that single locality more species than are known in the whole basin of the Mediterranean, excluding the minute species which have not yet been sought for among the fossils.

In earlier geological ages, during the deposition of the coal and other palæozoic rocks, the class of Crustacea presents a very different character. The gigantic Entomostraca, and the extinct family of Trilobites, take the place of the lobsters and crabs of later periods. But palæontological works illustrating the fossils of Sweden, Russia, Bohemia, England and France, have made us acquainted with as great a variety of species of those families as are found of the later representatives of the class in more modern deposits. So that among Articulata the class of Crustacea can be said to have been, at all periods, as largely represented, and to have shown as great a variety of forms as occur anywhere within similar limits in the present time.

The carcinological fauna of the whole Indian Ocean scarcely exceeds in variety or number of species that of Bohemia alone, as it is now known by the admirable investigations of M. Barrande.

From their minuteness and general structure, Insects might be excepted in such a comparison without affording a sufficient argument against the view I have taken of the subject, even if insects had nowhere been found in large numbers in a fossil state. For it must be plain that their preservation requires more favourable circumstances than the preservation of other animals more largely provided with solid parts. But though the fossil insects have not been sufficiently investigated in all geological formations, have we not several examples which show that in some geological periods, at least, they were as numerous as in the present day? The beautiful Monograph of Behrens, of the insects which occur in Amber, shows how varied these animals were during the period of the formation of that gum; and the unparalleled investigations of Professor Oswald Heer upon the insects of Oeningen and Radeboy have furnished us with means of comparison, which show that during the deposition of the Molasse of Switzerland, the insects were as numerous and as diversified there as they are anywhere in our day, within similar boundaries. And the fragmentary information which we already possess upon the insects of Aix in Provence, and those of Oeningen, will justify the expectation that insects will finally be found very numerous in all the geological periods, from that of the carboniferous deposit to the present day; that is to say, ever since terrestrial vegetation has had an extensive development. The discoveries by Hugh Miller of true trees in the old red sandstone, will justify the prophecy that insects will be found, some day or other, even among palæozoic rocks older than the coal period.

But what of the Vertebrata? Is there not evidence that, at the present day, they are more diversified and more numerous? Here again I answer, decidedly, No; granting only that there are periods during which the higher classes of these types did not exist, and that therefore, as a type the vertebrata of the present day are more diversified; but the individual classes, from the time of their appearance, have been in each former period as numerous, and even as various, as they are at present.

Let us apply to these the same measure which we have applied to the Radiata, Mollusca, and Articulata to justify this assertion, which seems so completely at variance with our knowledge of fossil vertebrata. Fishes occur, as is well known, in all geological formations. But should we compare the fossil fishes of each geological period, as they are known from a few localities, with the whole number of fishes which exist all over the world in our day? It would be as unphilosophical as it would be inconsistent with our knowledge of the geographical distribution of animals. Like all other living beings, fishes are located within definite boundaries, and it will be but fair to compare the fossil species of a given locality with the special Ichthyological faunæ which occur in different oceans, or in different fresh-water basins. Now with this rule we may institute a comparison of the fossil fishes with the living ones, with reference to their number as well as to their variety.

The number of species of fossil fishes known at present from the tertiary deposits, in a single spot upon the Island of Sheppy, is greater than the number of fishes which have been gathered around the coast of any of the islands of the Pacific Ocean, as far as we know the local Ichthyological faunæ of those regions; it is as great nearly as the whole number of fishes known from the shores of Great Britain. The same may be said of the fishes of Monte Bolca, or of Mount Lebanon, or of those of the white chalk of England, or of those of Solenhofen, or of those of the lias of Lyme Regis; and if we pass to older deposits, to the old red sandstone even—thanks to Mr Miller, and to the investigations of other British and Russian geologists—do we not know from that old formation as many fishes as from any of the more recent ones, or from any circumscribed marine basin? and is not the variety which occurs among them at each period as great, though of of a different character in each, as the variety which occurs at the present day? So that it can be fairly said, that at all periods, fishes have presented as great a variety of forms, and as numerous species, as under corresponding circumstances at the present day.

The class of Reptiles will allow similar conclusions; for though the giants of the class have chiefly been studied, do they not indicate an abundance and a variety of these animals during the upper secondary formations, as great as in any tropical region? and have we not sufficient indications among the tertiaries to be justified in expecting that they also will turn out to be more numerous than they are now known to be?

The class of Birds seems to form an exception in this view. But there seems to be particular reason why the bones of birds should be more liable to destruction and decomposition than those of other vertebrata. And whoever has traced the discoveries made recently among the fossils of this class, will certainly not insist upon a supposed scarcity of birds in former periods, but rather be inclined to admit that the limited number now known is to be ascribed to the deficiency of our knowledge rather than to a want of these animals in earlier formations,—indications of their presence having been ascertained for several tertiary formations, for cretaceous deposits, and even for deposits belonging to periods older than the chalk.

Fossil Mammalia are comparatively too well known to call for many remarks, after what has been said above. Let us only remember that the number of fossil species found in Brazil alone equals the whole number of Mammalia known to live at present in that country; that the fossil Mammalia of New Holland compare already favourably with the living species of that continent; and that the locality of Montmartre alone has yielded as many large Mammalia as occur all over Europe; and the Mauvaises Terres in Nebraska as many as may be found in North America now. So that, if we grant simply that among vertebrata the diversity has been increasing with the successive introduction of their different classes, the number and diversity of these different classes at each period has been as great as it is at present.

These facts are of the utmost importance with reference to the great question of the order of succession and gradation of animals in the different geological periods. They cut away for ever one of the arguments upon which the asserters of the development theory have insisted most emphatically. Before it could be granted that the great variety of types which occur at any later periods has arisen from a successive differentiation of a few still earlier types, it should be shown, that in reality in former periods the types are fewer and less diversified; and we have now shown that this is so far from being the case, that in many instances the reverse is really true. I have already attempted elsewhere to show in outlines what is the real order of succession of the great types of the animal kingdom. I need not therefore repeat here what may be gathered from the diagram in the Zoological Text Book I have published jointly with Dr Gould. I shall limit myself to a few more general remarks upon the special difficulties involved in a more thorough investigation of the subject.

The study of the order of succession and gradation of the organized beings which have inhabited our globe at different periods, presents indeed difficulties of more than one kind. Unhappily these difficulties have seldom been all considered in their natural connection by those who have ventured to consider the subject in its whole extent; thus presenting certain results as general which would require various qualifications to be true. In comparing fossils of one and the same or of different geological formations, it is in reality not enough to ascertain their true geological horizon, which we may call the *chronological element* of the inquiry; it is equally important that the differences or resemblances arising from the geographical distribution over the wide expanse of the whole surface of the globe, which we may call the *topographic element* of the question, should be also considered, for it is already known that within certain limits the same differences and resemblances which are observed at present between the animals inhabiting different parts of the globe existed already in former geological periods. We must, therefore, become acquainted with the *general biological character* of the epoch, as well as with the *locale faunæ* of each period. The tertiary faunæ of New Holland and the Brazils, for instance, resemble more closely the living faunæ of those parts of the world than they resemble one another. Our lists of fossils teem with chronological errors of the worst kind, arising partly from false identifications of strata which in reality belong to different periods, but the fossils of which are thus represented as having inhabited our globe simultaneously, when in reality they may have been separated by long periods of time, and existed upon the earth under very different physical conditions. This chronological confusion is further increased by the too extensive limits frequently assigned by geologists to the successive groups of rocks forming the crust of our globe. For instance, when the cretaceous or the oolitic formations are considered respectively as indivisible natural groups, and the fossils of all their subdivisions are enumerated in one single list as the inhabitants of a long period, an infinitude of anachronisms are presented to the mind, which no special mention of localities can rectify; and until the fossils of each of the natural subdivisions of these formations shall have been grouped together and compared carefully, as I have attempted to do in my Monographs of the *Trigoniæ* and of the *Myæ* of Switzerland and the adjoining countries, or as Al. D'Orbigny has done upon a much larger scale in his *Paléontologie Fran-*

çoise, no correct ideas can be formed respecting the succession of animals and plants characteristic of these long successive periods. I do not believe there is a single palæontologist, whose opinion is worth having, who can suppose, at this day, that any of the animals, the remains of which are buried in the lias, lived simultaneously with those of the inferior oolite, or these with those of the Oxford clay, or these with those of the upper division of the so-called oolitic formation. The same may be said of the different natural subdivisions of the cretaceous formation, and of the subdivisions introduced of late among the palæozoic rocks, by Sir Roderick Murchison and Professor Sedgwick, and in America by Professor J. Hall.

But even after this separation of the fossils, the synchronism of which may be fully established, our task is only fairly laid open, for then must begin the zoological identification of all the species, which has to be correct in every respect before general conclusions can be drawn from it.

In the first place, the *specific identity* of organic remains is not so easily ascertained as many geologists would seem to suppose, if we judge from their statements; but unless the validity of a species is sanctioned by a practised zoologist, it cannot be taken as a basis for sound generalizations in reference to questions of a purely zoological character. The number of false identifications which have been accumulated in geological works is truly frightful. It would be, however, very unjust to accuse geologists in general of inaccuracy for this; the fault is mostly to be traced to other parties from which the names were obtained. It should only be understood that the materials thus accumulated are no longer fit to be used for the discussion of the questions which have been raised with the modern progress of geology, and that a thorough revision of *all* the identifications made in former years is imperatively demanded by the modern progress of palæontology. It would be, however, sometimes amusing, were it not actually distressing, to see the manner in which some geologists deal with fossils, considering them simply as the characteristics of certain rocks, and hardly yet dreaming that there may be such a thing as a special zoology of the different geological periods, and that during each, local faunæ may have existed with peculiar animals, &c. The ideas about characteristic fossils are still very crude, and nothing is more absurd than the complaints about unnecessary multiplication of genera and species; as if both genera and species had not a natural existence, independent of the estimates of naturalists. It would be just as reasonable for astronomers to complain of the great number of stars, as for geologists to object to the investigations of zoologists, on the ground that they lead to the "making" of "*too many species.*"

The difficulty with reference to the identification of species is threefold: 1. Different species may be considered as identical; 2. Specimens of the same species in different states of preservation, or of different age or sex, &c., may be considered as distinct species; or 3. The same species may have been described by different authors under different names, and their identity afterwards overlooked by later writers. Who does not see what amount of error may accrue from the indiscriminate use of materials which are not first submitted to a very critical revision in these different respects, not to speak of the general difficulty of agreeing upon the limits of specific differences. With regard to this last point, however, I would say that whosoever would only use in discussing general questions materials revised candidly with the same principles, could not fail to obtain at least uniform results. And when the results of investigations made upon materials corrected in different ways by different authors are compared with one another, if these differences are kept in view, the disagreement in the results would not be found so great as it might otherwise seem. The astronomers and physicists have long learned to correct their observations before using them, and to take into consideration what they call the personal equation of different observers. Are we never to learn from them a lesson in the estimation of our respective investigations, and shall our facts for ever be used without being first corrected for all the possible causes of error and disagreement? As long as there are differences of opinion respecting the natural limits of genera and species, is it not absolutely necessary to reduce or expand the scale applied to the investigations of different authors, when using them for the same purposes, exactly in the same manner as thermometric observations made with the scales of Reaumur, or Celsius, or Fahrenheit, are reduced to the same standard, before being compared.

In the second place, *species must be referred to genera circumscribed within the same limits*, before they can fairly be compared, or at least lead to trustworthy general results. As long as certain bivalve shells of the carboniferous and oolitic series were referred to the genus *Unio*, it could appear that the family of *Naiades* began its existence at a very early period; but since the oolitic species of this kind have been ascertained to differ essentially from our freshwater shells, and to constitute by themselves a natural genus more closely allied to Crassatella than to Unio, nobody thinks any longer of looking for Unios in *marine deposits*. As long as certain fossil fishes of the Zechstein and Lias were referred to the genera Esox and Cyprinus, the families of which these genera are the types could be supposed to have extended their range far beyond the tertiary formations, before which, however, no one of their representatives is to be found. Before the Spatangoids were divided into natural genera, the genus Spatangus was mentioned among the fossils of the oolitic as well as the cretaceous and tertiary formations; now it is restricted to the last among the fossils, and found also among the living. I do not believe that a single genuine species of Gorgonia is found among the fossil Polypi, and yet that genus appears in the lists of fossils from the palæozoic period to the present time.

Since it is not my intention to enter here upon a special criticism of the innumerable errors of this kind still to be found in even modern lists of fossils, I shall not multiply my examples. These may be sufficient to show how important a correct generic identification of the fossils may be in the estimation of the order of sucession of organized beings; and I cannot but lament the utter want of consideration evinced even by many distinguished palæontologists in this respect, who seem to think that the knowledge of species is sufficient in itself to a proper appreciation of the order of creation, and that genera are arbitrary divisions established by naturalists merely for the sake of facilitating the study of species, as if the more general relations of living beings to one another were not as definitely regulated in all their degrees by the same thinking mind, as the ultimate relations of individuals to one another.

In the third place *the natural affinities of genera should be ascertained.* Unless the genera are referred to the families to which they truly belong, unless the rank of these families in their respective classes is positively determined, unless the peculiarities of structure which characterizes them is taken as the foundation of such an arrangement and further corroborated by the mode of development of their respective types it would be a hopeless task to attempt to determine the order of succession of the fossils in different geological formations. Before the Crinoids, which Lamarck placed along the Polyps, had been referred to the class of Echinoderms, nobody could have understood the beautiful gradation so fully ascertained now, which may be traced through all geological formations among these animals. Before it was ascertained that the little animal described by Thompson under the name Pentacrinus europæus, as a living Crinoid, for which M. De Blainville established the genus Phytocrinus, is in reality the young of a Comatula, nobody could have suspected the wonderful relations which exist between the changes animals now living undergo during their growth, and the order of succession of entire classes of animals during successive geological ages. As long as the natural position of Trilobites remained doubtful in the animal kingdom, the characters of the prototypes of the class of Crustacea could not be appreciated. Who does not see how impossible it was for those who classified the Trilobites with the Chitons to arrive at any sound results respecting the gradation and order of succession of these animals? Whilst now they are beautifully linked to the Macrura of the Trias, by the gigantic Entomostraca of the Devonian and Carboniferous periods. Again, the knowledge of the embryology of Crustacea gives us a key to a correct appreciation of the early appearance of the Macrura and the late introduction of the Brachyura. The removal of the Bryozoa from among Polypi to the class of Mollusks, will entirely change the aspect and relations of the faunæ of the palæozoic rocks. How different, again, would the order of succession of Mollusks appear, were we to adhere to Cuvier's view of separating the Brachiopods, as a class, from the other Acephala, to which they are now more correctly referred. The vexed question of the period of appearance of Dicotyledonous plants in the geological series would have been settled long ago, had it been placed upon its real foundation. It is not in reality to be argued upon palæontological evidence chiefly, for it resolves itself in the main into a botanical question, and the definite answer must depend upon the position finally assigned by botanists to the families of Coniferæ and Cycadeæ. If these natural orders of plants are really allied to the Dicotyledonæ, then this type begins with the palæozoic rocks in the Devonian system, and there is no gradation in the order of succession of plants during geological times. But if the view of Brongniart is more correct, if the Coniferæ and Cycadeæ have to be separated from the Dicotyledonæ as Gymnospermæ, and if, moreover, these latter should prove, as I believe they are, inferior even to the Monocotyledoneæ, then we may at once recognise in the vegetable kingdom a similar gradation of types as among animals. These examples may suffice to show what is required for a proper investigation of the order of succession of organized beings in the course of time, and how little confidence the investigations in this field deserve, which have not been made with due reference to all the points mentioned above. It is indeed only in the classes, the structure and embryology of which is equally well understood, we are able to discover the laws regulating the succession of animals and plants in geological formations, and our knowledge is at present still too imperfect to carry the investigation into all families of the animal kingdom. And yet enough is known to leave no doubt as to the final result; we may confidently await the time when the glory of the wonderful order of creation shall be fully revealed to us, and this may stimulate us to renewed efforts, since the success depends entirely upon our own exertions.

The geographical distribution of animals began only to be studied long after systematic zoology had made considerable progress; but even to this day the limits of the faunæ are nowhere circumscribed with any kind of precision, the principles upon which they might be determined are in many respects questionable, and a large number of animals are daily described without any reference to their natural distribution upon the earth; though much has already been done since Buffon, to place this branch of our knowledge upon a better foundation, and especially to ascertain the laws regulating the geographical distribution of certain classes and families considered isolately. The point which requires now particular attention, is the combination of these different types within definite regions, and their common circumscription within natural zoological provinces. This study would be particularly important with reference to the comparison of the local faunæ of former geological periods with those of the present creation. But since the latter even are comparatively little known, we must be satisfied to wait for the time when thorough comparisons shall be possible between the local faunæ of each and all geological periods *inter se*, and with those of other periods.

In closing this digression, I may sum up my criticism upon palæontological investigations, by saying that any generalization respecting the succession of organized beings which is not based upon materials in which the synchronism and succession of species and their geographical distribution is not duly considered, and in which the identification of species is not made with reference to sound zoological principles, with due regard to the equal limitation of genera, and also with reference to our improved classifications in zoology, is not fit to be trusted. All species taken into consideration should undergo a revision with reference to their chronology, their topography and their zoology, and in the last point of view the range and natural limitation as well as identity of the species, their generic affinities and their zoological classification should be equally tested.

Returning now to the main subject of this paper, I have further to say that the very fact that certain stratified rocks, even among the oldest formations, are almost entirely made up of fragments of organized beings, should long ago have satisfied the most sceptical that both *animal and vegetable life was as active and profusely scattered upon the whole globe, at all times and during all geological periods, as it is now.* No coral reef in the Pacific contains a larger amount of organic debris than some of the limestone deposits of the tertiary, of the cretaceous, or of the oolitic, nay, even of the palæozoic period, and the whole vegetable carpet covering the present surface of the globe, even if we were to consider only the most luxurious vegetation of the tropics, and leave entirely out of consideration the whole expanse of the ocean, as well as those tracts of land where under less favourable circumstances the growth of plants is more reduced, would not form one single seam of workable coal to be compared to the many thick beds contained in the rocks of the Carboniferous period alone.

On the Artificial Formation of Minerals.

There are a number of minerals, with regard to which most mineralogists, geologists, and chemists, are of opinion that they can only have been formed by crystallization from a melted mass. A considerable portion of these minerals are, however, infusible ; or, at least, require such a temperature for fusion, as cannot reasonably be supposed to have been concerned in the formation of the rocks in which they occur. Some of these compounds, on the other hand, may be easily formed by fusion at a moderate temperature. Thus, more than thirty years since, Mitscherlich showed that augite or pyroxene—one of the most widely distributed minerals—may be formed by melting together silica and various bases of the magnesian series, in such proportions that the oxygen of the acid amounts to twice as much as that of the bases. He also showed that this mineral substance, with its proper form, occurs in the slags obtained in metallurgical operations ; and the subsequent examination of slags has led to the recognition in them of several other compounds identical with, or analogous to, native minerals.

Nevertheless, there are a great number of minerals, in whose origin, it is very probable, intense heat has exercised an essential influence, which have never been produced artificially, nor observed in the products of metallurgical operations. The very happy, and in some respects fertile, idea of Ebelmen to expose substances to the joint influence of heat and a solvent capable of being volatilized, and thus to obtain them crystallized, has furnished some very valuable results; but, although boracic acid—the solvent used—has been found in many native minerals, in which its presence had not been suspected, still its occurrence is too rare to admit of the opinion that it has played any very considerable part in the production of the more widely distributed minerals constituting the earth's surface.*

Forchhammer has recently made experiments of the same character as those of Ebelmen, but with substances, as solvents, which are less rare than boracic acid—chloride of sodium, calcium, magnesium, &c.

The production of apatite was the object of his first experiments; and he was led to them by the results of his analyses of sea water, and his observations of the constant presence in it of phosphate of lime, together with a still smaller amount of fluoride of calcium.

After failing in every attempt to produce apatite in the wet way, and guided by the circumstance that apatite occurs chiefly in lava, dolerite, granite, and metamorphic rocks, under conditions which appear to indicate an igneous origin, he came to the conclusion that if this was the case, chloride of sodium might have been concerned in its formation.

By melting phosphate of lime with chloride of sodium, and allowing the mixture to cool very slowly, a mass was obtained which presented a great number of cavities containing an abundance of long columnar crystals. The residue left, after treating this mass with water and then with acetic acid, consisted of—

Lime, ...	5·80
Hydrochloric acid, ...	5·61
Phosphate of lime, ...	88·07
Oxide of iron, ...	a trace;

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* Ueber die Einwirkung des Kochsalzes bei der Bildung der Mineralien *Annalen der Physik* und Chemie, 1854, No. 4.

corresponding therefore closely with Ramelsberg's calculation for apatite.

The crystals obtained were too small for measurement, which the author considers sufficiently accounted for by the artificial conditions of their production. By examination, with the aid of the microscope, they were found to be six-sided prisms with terminal planes, and grooved lateral planes like beryl. In other respects they had the closest resemblance to the acicular crystals of apatite, occurring in rocks at Capo di Bove.

The density of this artificial apatite was found to be 3·069, and the hardness so great that a slab of fluor-spar became dull when rubbed with the powder.

The solution of phosphate of lime in fused chloride of sodium, and its separation on cooling, furnish an excellent means of detecting minute quantities of phosphoric acid in rocks, &c. For this purpose the powdered substance is heated with 50 per cent. of chloride of sodium, which, when the substance is tolerably fusible, separates from the silicates as an upper layer. When the substance is not fusible, the chloride of sodium remains partially mixed with it, in cavities distributed throughout the mass, and presenting, after the solution of the chloride, a remarkable similarity to the vesicular cavities of amygdaloid. The small crystals of apatite generally project like hairs from the surface of the partially dissolved mass, and being soluble in very dilute hydrochloric or nitric acid, they may be collected by that means and estimated. The author has in this way detected phosphoric acid in greenstone belonging to the primitive and transition formations of Scandinavia; in the greenstone, occurring as boulders, in the more recent formations; in that of the trap formation of Greenland; in the basalt of Steinheim; in a course granular basalt or lava from Iceland; in three varieties of granite and gneiss from Bornholm, and in two varieties of mica schist. From one Bornholm granite, remarkably fine and distinct, crystals of apatite were obtained.

The observation, made some years ago by Fownes, of the presence of phosphoric acid in rocks, thus gains further confirmation, in addition to the testimony of Swanberg and *Struve*.

The occurrence of apatite in the magnetite beds of Scandinavia, and the composition of the bog iron-ore of the same locality, suggested the possibility that the former might have originated from bog iron-ore under the influence of chloride of sodium at a high temperature. The bog iron-ore contains, besides, oxide of iron, phosphoric acid, lime, silica, titanic acid, and carbonaceous organic substance. The latter ingredient might correspond to the remarkable bituminous substance of the magnetite beds; and the silica, lime, and magnesia might be supposed to form, with oxide of iron, the numerous compounds of the amphibole series occurring in the magnetite beds, while apatite and titanium compounds might also be derived from the constituents of bog iron-ore.

For the purpose of ascertaining the behaviour of bog iron-ore when melted with chloride of sodium, a direct experiment was made with a pound of the ore, and half a pound of chloride of sodium. The cooled mass presented cavities which, when the chloride of sodium was dissolved out, were found to contain apatite crystals. The ore itself had become black, strongly magnetic, and had acquired such a hardness as scarcely to be scratched by steel, together with a perfectly conchoidal fracture.

In the larger cavities the mass was covered with small, sharply defined crystals, which, when magnified, were found to be regular octahedrons. The ore was therefore actually converted into magnetite, and the phosphoric acid had separated, as apatite, from the oxide of iron. In a comparative experiment with bog iron-ore alone, it did not show any signs of fusion or crystallization; the colour, though darkened, was still brown.

There is a great amount of evidence for the opinion that the blue tinge of some minerals, especially silicates and aluminates, is intimately connected with the presence in them of phosphate of iron, and that vivianite is the hydrate of the compound, to which the colour of cyanite, sapphirine, spinell, and corundum, as well as of fluorite and apatite, is owing, at least in many instances. The author having ascertained, by analysis, the presence of phosphoric acid and iron in these minerals, endeavoured to obtain further evidence by synthetical experiments, and, first, to find whether the anhydrous phosphate of iron had the same colour as the hydrate.

With this object, he heated protosulphate of iron with ordinary phosphate of soda, and an additional equivalent of soda, to obviate the formation of pyrophosphate, but was unable to effect the formation of phosphate of iron by double decomposition, as the mixture proved to be infusible at a temperature which rendered cast-iron perfectly liquid. He therefore had recourse to chloride of sodium, which he added in large excess, and exposed the mixture to the influence of an intense white heat for half an hour. When the crucible was thoroughly closed, and the heat had not been maintained so long as to cause considerable volatilization of the chloride of sodium, the melted mass was quite homogeneous, and generally colourless, while its surface was covered with deep red micaceous laminæ. By treatment with water a fine crystalline residue was obtained. That portion of the melted mass which was in contact with the sides of the crucible had acquired a dark violet colour to the depth of two or three lines, and very similar to the colour of some varieties of fluorite. The principal part of the mass, however, was colourless protophosphate of iron; at the surface, where oxidation was comparatively easy, phosphate of iron had been formed.

When, on the contrary, there was a crack in the crucible, through which a portion of the chloride of sodium ran into the fire, or the temperature was sufficiently high and protracted to effect the volatilization of greater part of the chloride of sodium, the appearance of the melted mass was quite different. The cavities in the chloride of sodium were then filled with black micaceous crystals, which had the greatest similarity to micaceous hematite. This substance consisted of protoxide and oxide of iron and phosphoric acid, and, rubbed to powder with water, presented a deep blue colour

It is remarkable that this phosphate of iron, when oxidized, while washed with water, does not, like the phosphate of iron occurring in peat-bogs, and in some masses of lava, assume a blue colour when exposed to air; but becomes brown gradually, and without passing through any shades of green or blue.

The results of these experiments, therefore, show that phosphate of iron is capable of producing, in combination with alumina especially, but likewise with other substances, a series of colours of which the intermediate phase is pure blue; on the one side the dark violet seen in some varieties of fluorite, and on the other the bluish-green of the Arendal apatite. In some instances these colours may pass, by a subsequent oxidation, into yellow and red shades, like those so frequently observed in cyanite.

The fact that the largest and most perfectly developed crystalline minerals occur either in druses or upon lodes, has been brought forward by Bischof as evidence in favour of their production through the agency of water. His whole argument, however, ends in establishing, by general reasoning from physical and chemical principles and circumstantial evidence, a probable hypothesis, in place of vague and often contradictory opinions hitherto entertained. As yet the hypothesis is destitute of any such positive experimental evidence as would justify its reception as an adequate theory of mineral development and alteration.

The argument for the aqueous origin of minerals derived from the presence of constitution water in minerals, zeolites, &c., has recently been met by direct experimental facts,* which, at least, destroy that portion of it that is intended to prove the impossibility of their formation by igneous agency, although the conditions of these experiments were probably too artificial to admit of their being applied as evidence for the mode of production of native minerals.

Even admitting the general proposition, that native minerals have been produced through the agency of water, it is in very many instances difficult to furnish any satisfactory explanation of the processes in their details. Crystallization in the ordinary way does not appear very probable; for, without reference to the assumption of indefinite periods, savouring too much of a past phase of geological speculation, the very minute solubility of the substances would, judging from analogy, seem to justify the opinion, that in gradually separating from solution in consequence of evaporation of water, they would be distributed over a considerable surface, rather than at particular points, as crystals are found in druses and upon lodes.

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* The production of hydrated silicate of lime, $3\ CaO, 2\ SiO_3 + aq.$ in crystals, by melting a mixture of lime and silica with caustic potash, and of crystals presenting all the characteristic features of native chabasite, by simply heating fragments of palagonite to incipient redness.—See Bunsen on the Rocks of Iceland; Poggendorff's Annalen, 1851, No. 6; and Scientific Memoirs, 1852.

The quantity of water evaporated in the formation of minerals by crystallization in this way would be enormous, in the case of quartz amounting to 25,000 times its volume at least. Moreover, when it is considered that this evaporation must be assumed to take place in the midst of immense masses of rock, perhaps saturated with water, the view which ascribes the formation of minerals to crystallization from solutions in the ordinary way certainly assumes a very questionable aspect.

The occurrence of minerals presents a great number of facts which unmistakably indicate a segregative action, in consequence of which particular compounds occur in masses, or as crystals imbedded in a matrix of a different kind; and although the intimate nature of this process is not understood, it is highly probable that the production of minerals by the agency of water was effected under some such conditions, by which the molecules in passing from the liquid to the solid state were brought within the range of their aggregative forces in a manner more favourable to the formation of crystals than deposition from so enormous a proportion of water by mere evaporation.

From a conviction of the need of experimental evidence in favour of the aqueous origin of minerals, as well as of a more minute investigation of their mode of production, and guided by views similar to those expressed above, Drevermann* has instituted some experiments with this object, which, though not very extended, are sufficiently interesting to merit further prosecution.

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* Liebig's Annalen, January 1854.

The results of Professor Graham's researches on the diffusion of liquids, suggested to him the idea that by means of this process a very gradual precipitation might be effected, which would be eminently favourable to the production of insoluble or sparingly soluble substances in a crystalline form.

The first experiment, directed to the production of insoluble lead salts, was arranged in the following manner:—

Powdered nitrate of lead was introduced into a tall cylindrical glass and covered with water; chromate of potash containing carbonate and sulphate was placed in a similar glass with water, and both were then immersed in a large vessel of water. The saline solutions formed at the bottom of the glass cylinders diffused slowly upwards, and after some months, the water in the large vessel was found to contain nitrate of lead. There was then formed upon the outer edge of the second cylinder a yellow amorphous deposit, which gradually extended towards the inner edge and assumed a darker colour. Upon this amorphous deposit, small patches of a bright purple red colour appeared after a time and rapidly increased to little warty protuberances, and finally formed a ring extending downwards in a horizontal zone round the inner side of the cylinder. The other portion of the cylinder became covered with a reddish film, which, after a few days, was seen to consist of small crystals. These increased rapidly in size, forming concentric groups of acicular crystals of a bright red colour. Some attained a length of four or five millimetres, and then fell to the bottom of the liquid. The crystals had adamantine lustre, and corresponded in crystalline form as well as in every other particular with native lehmannite (PbO, CrO_3).

Upon the dark red ring rhombic plates of a cochineal colour were formed and grouped together in branches, and agreeing in characters with phœnicite ($3\ PbO, 2\ CrO_3$). The formation of these two compounds took place in such a manner, that near the mouth of the cylinder there was a zone of phœnicite only; lower down, crystals of both compounds were associated, while below this point there was another zone of lehmannite only; and when the liquid was tested with litmus paper, that portion within the latter zone was alkaline, while that within the former was neutral.

Upon the sides of the larger vessel, and the outer sides of the two cylinders crystals of two different forms were deposited—colourless six-sided prisms, with a vitreous lustre, and tabular brittle crystals also with a vitreous lustre. The former were soluble in dilute nitric acid with effervescence, and proved to be cerussite (PbO, CO_2); the latter were insoluble in dilute nitric acid, and proved to be anglesite (PbO, SO_3).

Experiments of a similar kind have been commenced by Vohl,* who uses very dilute solutions of equal density, and makes the diffusion take place through membrane, paper, or a thin plate of baked clay. B. H. P.

On the Influence of Undulating or Hilly Ground in Checking Currents of Wind. By RICHARD ADIE, Esq., Liverpool. Communicated by the Author.

Referring to my communication in No. 113 of this Journal, I return to the subject in order to avail myself of the table of the fall of rain in the Lake District, published by Mr Miller at p. 88 of the same Number. Also to give the result of some further observations, which, although not directly connected with the question under discussion, have a collateral relation, and were suggested to me through the consideration of the effect of hilly ground on currents of wind.

The weight of aqueous vapour which crosses a ridge of sea-board of 100 miles long, was stated to be 4¼ millions of tons per hour, counting the velocity of the wind at the mean rate ascertained at Liverpool. This weight, however, is also much governed by the thickness of the stratum of air in motion, which, for the calculation, was assumed to be 100 yards. But in the Lake District where Mr Miller's rain gauges are situated, a portion of them at elevations from 1000 to 3000 feet above the sea-level, the hourly weight of aqueous vapour which crosses over a district is probably far greater.

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* Liebig's Annalen, October 1853.

Mr Miller's gauges are distributed over 25 localities, in all of which the annual fall of rain greatly exceeds that of West Lancashire; the mean depth shown by the 25, given in

in his table, is . . . . . 82·88 inches,
From which deduct annual fall at Liverpool 28·05 ,,
54·83 ,,

the excess of rain due to hilly ground. A square of 25 miles a side or 100 perimeter would inclose the chief portion of the district in question; the yearly excess of water of 54·83 inches deep, distributed over the area of the square, shows that the condensation of aqueous vapour amounts to 252,852 tons weight per hour. If the 100 miles perimeter was made to inclose a circular area in lieu of a square one, the weight of water condensed per hour would be a little over ¼ more.

Sand Hills.—The action of a stormy atmosphere on a flat sea-chafed sandy beach, has the effect of producing a belt of sand hills that in some degree exercise the influence of hilly or undulating ground in checking currents of wind. I wish to submit the view I take of the formation of these hills, which, I trust, may prove of interest, seeing that the question of staying the progress of sand is in some countries one which is studied with anxiety. On the shores of France, of Holland, and in this neighbourhood, grasses are cultivated for the purpose of binding the sand, and preventing it from damaging adjoining fields. And it has been argued that in Egypt the object the ancients had in rearing those masses of masonry, the Pyramids, was for a like purpose.

In Liverpool bay the tide flows over extensive sand-banks, and beats on a smooth sandy shore; near the high-water line the sand is of a clear, sharp character, through which water percolates freely; specific gravity 2·58. I have repeatedly noticed that a brisk wind playing on a bank of this kind, within two hours from the time it had been dried by the tide, detached particles of sand, which the wind carried along the surface of the ground in the form of light, fleecy-like clouds. When this process is extended through ages, the result of it is that a quantity of sand is lodged above high-water mark by the effect of the sea breezes. If we come to consider the relative strength of land and sea winds, the preponderance of force will always be in favour of the latter, for they are unchecked by objects, like arboreal vegetation, which the land-winds encounter. After they cross high-water mark, the respective character of the two changes; the land-breeze there makes its escape from the obstacles which reduced its force, while the sea-breeze at the same point begins to encounter them. Thus, if the land and sea winds on a coast are supposed to be of equal duration throughout the year, the greater force of the latter would leave an excess of sand above high-water mark; which is the case which occurs in nature. When the shores of Liverpool bay are viewed from a little distance, they appear to be skirted by a ridge of sand of from twenty to fifty feet high. This ridge nearer hand is found to be not continuous, but to have gaps at intervals, through which the ground inland may be reached without ascending more than a few feet. These gaps appear to me to serve the purpose of permitting the wind to escape with less resistance than if the sand had formed an undivided ridge. *The phenomenon of the formation of sand-hills on parts of our coasts which supply the requisite conditions, can be explained by viewing them as the forms of least resistance the wind has arranged sand it has brushed up from the beach, and over which it has to cross.* The dome or conical hill is the type of the form of least resistance, which in our climate is much modified by vegetation through the roots and stems of plants binding the sand. In Liverpool bay, the belt of sand-hills is broadest in the neighbourhood of Formby Point, where the flat character of the country inland offers slight impediments to the progress of the wind; they attain the height of fifty feet, and the specific gravity of their materials agrees exactly with that of the adjoining beach, namely, 2·58.

A friend of mine, who has examined the sand-hills on the coast of Brazil, informs me that on the northern part of that coast domes of pure sand rise to the height of 150 feet. Their superior elevation in that place he accounts for by the steady regularity of the sea-winds and the dry nature of the climate. On the shores of the Baltic, in the neighbourhood of Memel, I remember to have seen hills of sand about 100 feet high; but these I consider to be natural elevations of the ground, covered with sand, for I only found them at one point.

The conditions required for the formation of sand-hills on a sea-board are, a flat coast, a scanty sea-chafed beach, and a stormy atmosphere. To those who are familiar with different forms of beaches, localities will suggest themselves, where, owing to the want of one of the conditions required, there are no sand-hills. At our headlands, for example—Ardnamurchan, Point of Ross, the Ormshead—where the winds and waves play in their "wildest and angriest moods," sand can find no resting-place. Again, in the estuaries of the Dee, the Mersey, the Forth, and Morecambe bay, there is abundance of sand reposing on a flat sea-beach; but in these places the winds have not force enough to detach the sand and carry it above high-water mark in sufficient quantity to form hills.

A question of interest in this inquiry, but which is not easily determined, is the supply of sand from the sea-board requisite for the maintenance of a belt of sand-hills. The ground on the landward side of such a belt shows that there is a transfer of sand to the inland, and when it meets a low wall it rises over it; where it meets a high fence wall, the sand is thrown back into a ridge about two feet from the base of the wall. If the quantity of sand annually carried inland could be ascertained, then, where the condition of the sand-hills are stationary, that would measure the supply from the sea-chafed beach.

I fear that the view that the Pyramids were erected by the ancient Egyptians to stay the progress of sand from the Desert finds no support from the foregoing remarks; for in their forms they approach to the sand domes which offer the least possible resistance to winds. And the masonry in the Pyramids, arranged as a series of dikes, these in time to become sand ridges, would check the advance of sand from the Desert more than if the materials were put in the form of Pyramids.

The manner the tide arranges the materials on a sea-beach may here be noted as connected with the source of sand-hills. Where the shore is sandy and free from pebbles, the sand at half-tide level is finer and less permeable to water than it is near high-water mark, with the specific gravity of the two nearly equal. Where the shore is composed of sand and stones, the former occupies the half-tide level, and a belt of pebbles the high-water ground. This effect of the waves throwing up the coarser part of the sand to the top of the tide is very marked on the coast of Denbighshire, on the borders of the Irish Sea; also in Brodick bay, in the Island of Arran.

Prize Subjects proposed by the Society of Sciences at Harlem for the year 1856.

The Dutch Society of Sciences resident at Harlem proposed a great number of prize subjects for competition in 1854. Three questions only have been taken up by the competitors; 1*st*, That on the fossil vegetables of the chalk formations; 2*d*, That on the air and water of the Low Countries in the neighbourhood of the sea, of which the Society required an examination in respect to the existence or non-existence of iodine; 3*d*, That on the spectrum of the electric light, and the differences which the rays of Frauenhofer present when the luminous arc is formed between different metals. The last of these questions is the only one that has been treated in such a manner as to deserve the prize. The author of the memoir is M. Masson, Professor of Natural Philosophy in the Imperial Lyceum of Louis-le-Grand, at Paris. The society now proposes, for the competition of 1856, the following prize subjects:—

1. Some natural philosophers allege that a part of an electric current, passing along an electrolyte, traverses it without exercising any chemical action. The society requires that this opinion should be submitted to a rigorous experimental examination; and that, in case of it being found correct, the experimentalist should determine, at least in respect to six different electrolytes, the numerical relation existing between the part of the current which decomposes the electro-

lyte, and the part for which the electrolyte appears to be possessed of conductibility similar to that of metals.

2. Some recent experiments of M. Faraday, made with long metal wires covered with gutta-percha and immersed in water, have shown that the celerity of the electricity is not always the same in all conductors, metallic or otherwise. The Society desires that the circumstances which modify this celerity should be determined by exact experiments.

3. It likewise requires that a rigorous examination should be made of the phenomena which some chemists still explain by admitting the existence of the force called catalytic, in order to decide whether it be proper definitively to admit or reject the existence of this force.

4. M. F. G. W. Struve published in 1847, in a work entitled *Etudes a'Astronomie Stellaire*, certain views on the structure of the universe and the transparency of space, which have been approved of by some astronomers, and disputed by others; among the former, M. Encke has declared that he considers these ideas as hypothetical and without foundation. A prize is offered by the Society for the best memoir, the author of which shall point out, as the result of deep study, what the actual state of astronomy allows us to consider as proved, or at least as probable, in the structure of the universe.

5. By another question in its programme, the society requires it to be determined where, when, and how, sugar is produced in the human body.

6. It offers another prize for a comparative description of the lymphatic and chyliferous vessels in fishes. It requires, 1*st*, That the different relations of these vessels and those of the sanguineous system should be examined; 2*dly*, That the observations of MM. Fohman and Treviranus on the lymphatic vessels, should be repeated and discussed. The competitor must compare, in this point of view, at least three very different families, and describe, as completely as possible, the entire system of these two kinds of vessels in the same species of fish, accompanying the descriptions with figures.

7. To inquire by a physiological examination, experi-

mental and comparative, what is the function of the particular matter secreted in the large intestine of many mammifera. This examination, forming the subject of the 7th prize, ought to embrace at least the Carnivora, Ungulata, and Rodentia.

8. To inquire if there is a well established relation between the hypertrophies of the spleen and a morbid state of the blood characterised by an abundance of white globules (leucohemia). To illustrate this subject by anatomico-pathological investigations and clinical observations.

9. With the view of terminating the uncertainty which always rests on the manner in which reproduction takes place in the Algæ, the Society requires that it should be made the subject of new investigations, and that the development, from the embryo to the perfect state, of at least three plants belonging to different families, be observed, described, and as far as necessary illustrated by drawings.

10. To show what are the characters by means of which, either by the examination of fossils or otherwise, it is possible to decide with certainty whether the alluvium formations have been deposited in fresh water, in water more or less saline, or in the sea. To confirm the exactness of the characters which shall be indicated, by the examination of different beds of the alluvium formations, whose origin is not doubtful.

11. To make a thorough geological examination of the formation situated at the ancient embouchure of the Rhine, near Katwijk, in order to decide, if possible, by what causes it was closed up, whether violent cataclysm, or progressive encroachments of the land. To describe the vestiges which this embouchure has left.

12. To give the geological and palæontological description of one of the inhabited Neerland Indian Archipelago other than the island of Java, and to determine the geological epoch of the formations of the island.

The prize for each of these questions is a gold medal of 150 Dutch florins, to which may be added, if the Society think proper, a gratuity of the same value. The memoir may be written, at the choice of the competitors, in any one of six languages; Dutch, French, English, Italian, Latin, or German. They must be addressed in the ordinary forms of competition, to the Secretary of the Society, M. J. G S. van Breda, before the 1st of January 1856.

Researches on the Artificial Production of Minerals, belonging to the family of Silicates and Aluminates, by the reaction of Vapour on Rocks. By M. DAUBRÉE.

Modern geology admits, as demonstrated, a modification of rocks in contact with, or in the vicinity of, massive crystalline formations. It is this theory which has procured for them the designation of *metamorphic rocks.*

Since the memorable experiment of James Hall, elevated temperature has been admitted as the principal agent of metamorphism. But the intervention of heat alone cannot explain the important modifications which rocks have undergone in many countries; complex chemical actions have contributed to alter the primitive type.

In former researches, which the Academy has condescended to receive with favour, I have been principally occupied with the mineral formations that contain repositories of tin, and the reciprocal reactions of vapours, the one upon the other. The new experiment, the results of which I have now the honour to submit, along with a few modifications in the processes, have the same theoretical idea as I commenced with, and now extend the inquiry to the crystalline or azoic rocks.

The chloride of silicium reacting, in a state of vapour and at the temperature of red heat, on the basis which enter into the constitution of rocks, becomes decomposed, forming by the change chloride of calcium and of silicic acid. Sometimes this acid remains free, sometimes it combines in excess with the base, and forms simple or multiple silicates.

This reaction is remarkable in this respect in a chemical point of view, and it is so especially in a geological one, that the *silicic* acid thus originating, and the silicates produced from it, have a great tendency to crystallize. The crystals are small, but in general very distinctly defined.

It is besides important to observe that the crystallization of these compounds takes place at a temperature much below their point of fusion.

With lime, magnesia, alumina, and glaucina, we obtain *crystallized quartz* under the ordinary form of a pyramidal hexagonal prism, and a part of the base passes into the state of silicate.

It is in this that the silicate of lime, named *Wollastonite*, has a great tendency to be produced, in rhomb tables with two broad truncated faces which replace the obtuse angles, the constant form of the natural crystals. These tables are often grouped perpendicularly between each other like the prisms of Staurotide.

It is in this way that, with the magnesia, we obtain *peridot* in rectangular prisms.

Alumina yields a silicate in elongated prisms with oblique bases, not acted upon by acids, and infusible, with all the characters of *disthene*. It is interesting to see in this case the *chloride* of aluminum forming at the expense of the silicium.

In order to form a double or multiple silicate, it is necessary not only to mix the bases, that they may become silicified in the suitable proportions, but also to furnish the oxygen necessary for the formation of the *silicic* acid, by adding in excess one or other of them, or lime.

A mixture of lime and magnesia yields crystals of *pyroxenous diopside*, without colour and of perfect limpidity; they present the large truncation and bevelment common to augite.

Seven equivalents of potassa or soda, one equivalent of alumina, or else an equivalent of alumina with six equivalents of lime, produce, under the reaction of *chloride* of silicium, crystals of oblique prisms with obtuse bevelments, nearly unaltered by sulphuric acid, fusible by the blow-pipe. and in short presenting all the characters of the felspars.

By the same process, and by varying the nature and proportion of the bases submitted to the chloride of silicium, I have obtained silicates with the crystallographic and chemical characters of Willemite, idiocrase, garnet, phenakite, *emerald*, euclase, and zircon.

By mingling the elements which correspond to the composition recently given by M. Rammelsberg for the magnesian and ferromagnesian tourmalines, and adding to them an excess of magnesia or lime to supply the silicium with oxygen, I have obtained, among crystals of quartz, very well-defined hexagonal prisms, which present all the exterior and chemical characters of tourmaline.

The chloride of aluminum may be employed in the same way as the chloride of silicium. When treated with lime at a red heat, it produces chloride of calcium and of alumina in crystals, which may be referred to the proper types of corundum, the hexagonal prism, and acute pyramids.

The same reaction takes place with magnesia, and besides, in the latter case, a part of the reproduced alumina may be combined with the magnesia in excess, so as to produce *spinelle*, recognizable by the form of its crystals in regular octahedrons truncated on the angles. At the same time, it is a better plan, in order to obtain spinelle, to bring together a mixture of chloride of aluminum and chloride of magnesium, and lime brought to a red heat. With the chloride of zinc and aluminum, we produce the zinciferous spinelle, or *gahnite*.

The chloride of titanium brought over lime, along with the other crystals, afterwards examined, yields oxidized titanium, under the form of *Brookite*.

The oxide of tin, obtained in a similar way, is in crystals of the same form as that which I had formerly produced by reaction on steam. Thus the form of a rectangular prism remains, for the oxide of titanium and for the oxide of tin, produced by decomposition of the chlorates of these metals, at temperatures at least between 300 and 900 degrees.

By causing the perchloride of iron to react upon lime, I have obtained *oligistic iron*, both in the most distant specular crystals, like those of St Gothard, and in transparent hexagonal plates, presenting by refraction the red colour of the ruby. The perchloride of iron mingled with the chloride of zinc yields, in the same conditions, a crystallized combination analogous to Franklinite.

Lastly, crystallized magnesia or periclase of the Somma, may likewise be easily obtained by the reaction of lime on the chloride of magnesium, which is found among the abundant chloriteous vapours of the fumeroles of Vesuvius. The same chloride, decomposed by steam, likewise gives periclase, and the chloride of zinc furnishes *oxidated zinc* crystallized.

The results which have been indicated, lead to geological consequences which can be referred to here only very briefly.

I do not mean to affirm as a fact, that all the silicates, which compose the mass of crystalline rocks, are formed by vapours. But even among the melted rocks of Vesuvius, a certain number of minerals are found, to which M. Scacchi has recently drawn attention, and which appear to be the products of sublimation.

Among the minerals of the most ancient formations, there are likewise many which could not come, in the way of fusion, to line the fissures where these minerals are now met with so much insulated; such as the pyroxenous diopside with garnet of Piedmont and the Oural, the adulaire and pericline felspars of the Alps, the epidotes and axinites of the Oisans, and many others.

The privileged richness of the crystalline limestones in minerals, often strangers to the neighbouring rocks, cannot result solely from the circumstance that the lime, reacting in them on the silica, has formed particular silicates. Whatever may have been the original impurities of the limestones, corundum, spinelle, periclase, and chondrodite, could not become developed in them, without the subsequent introduction of chemical agents which were foreign to them.

All the varied productions of transport, silicates, aluminates, oxides, and other combinations, whether formed in fissures, or in the heart of rocks now become very compact, appear to me to be explained in the most satisfactory manner by the intervention of emanations of chlorides and fluorides. Besides, there is nothing to prevent us conceiving, in regard to compounds so volatile and penetrating, that their action should extend, on parting from the centre where they are set free, over considerable thicknesses, such as those of the crystalline rocks of the Alps or Brazil. Sometimes the substitution of the silicates thus formed has been only partial, as in many of the crystalline limestones which remain to us as perpetual *witnesses* of the ancient exhalations emanating from the neighbouring eruptive rocks. Sometimes the effect has been more complete; and even the primitive mass may have disappeared, in the state of soluble chloride, as well as the water which has formed the oligistic iron of volcanoes.

If we turn from the example of crystalline limestones and dolomites richest in minerals, to those of St Gothard, Sweden, Finland, and the United States, we perceive that the presence of chlorides mingled with fluorides, and sometimes sulphurated compounds, accounts for the formation of their most characteristic minerals. We must include, in this explanation, the rich deposits of red oxidated zinc, with the Franklinite of New Jersey, as well as diverse masses of oligistic iron and oxidulated iron, which have also been produced in the limestone.

We see magnesian compounds, such as spinelle, chondrodite, mica, pyroxine, amphibole, warwickite, and serpentine, accumulated sometimes with marked predominance, in limestones which contain no magnesia. This fact, hitherto unexplained, should be regarded as a consequence of the different chemical affinities of lime and magnesia; for we always find, in our experiments, the chloride of magnesium to be precipitated by lime; and when both these bases are in connection with chloride of silicium or aluminum, the lime yields its oxygen, and the magnesia, remaining in the state of oxide, enters by preference in the oxidized combination with the regenerated silica or alumina. The same principle explains the presence of the magnesia to the exclusion of the lime, in the oxidulated irons. Must we ascribe to the same cause the preponderance of the magnesia over the lime in the elements of granite and serpentine?

The causes to which quartz and silicates owe their presence, principally in granitic rocks, has long been a difficulty in all the hypothesis of the formation of the primordial system of rocks. But, we now perceive in our experiments, that the quartz crystallizes at the same time, and even later than the silicates, at a temperature which scarcely exceeds the cherry-red, and, consequently, vastly below their point of fusion.

Is it not likewise the same cause which appears sometimes to withdraw the quartz from the silicates or aluminates of the base; as in granite, when it envelopes crystals of cymophane, instead of having formed a double silicate like emerald and euclase ?

If mica still exhale by heat, fluorides of silicium and boron, or of lithium, dare we affirm that the granitic pastes did not likewise, at the time of their origin, enclose chlorides of silicium, boron, or aluminum; which are wanting, it is true, among the vapours now collected near volcanic orifices, when they are decomposed and precipitated by steam on coming in contact with the atmosphere, and where we see them notwithstanding contribute very probably to the formation of silicates, now attributed by the best observers to a product of volatilisation ? Do we not still find, moreover, the chloride in considerable quantity in certain masses, such as the zircon syenite of Norway, and the rock of Ilmen (miascite), where this body is principally combined in eleolite, and where it appears to have brought zirconium, tantalum, along with all the assemblage of rare elements which are the accompaniments of these rocks ?

It is by no means demonstrated that the presence of a certain quantity of water should be, at high temperatures, an obstacle to such reactions, since we see silica and alumina become separate and anhydrous, from an aqueous solution at a temperature of from 300 to 400 degrees. And if, hitherto, experiments have referred principally to *limited conditions* of the different modes of formation, by the humid way and by the dry way, the same effect produced in these extreme cases, as the quartz and corundum, would perhaps sufficiently authorize us to conclude that it would likewise take place in *intermediate* conditions.—(*Comptes Rendus de L'Académie des Sciences*, 1854.)

Siluria—Present State of Geology.

The geologist is now in possession of a vast amount of facts bearing on the history of the earth's structure, and the different epochs that extinct organic beings appear to have passed through; and the most important of these facts have been studied with a strict philosophic spirit, and sound practical results have been drawn from them, and are now of the utmost advantage for the progress of both science and art.

No man of science deserves a deeper debt of gratitude from his country for the services he has rendered to it than Sir Roderick Murchison. Sir Roderick did not only lay down his military profession, but sacrificed a large portion of his great fortune, and the best part of his valuable life, in exploring the structure of what all must admit to be the most difficult part of the earth's crust, viz., the protozoic, or the first epoch of organic existence. On this epoch, Sir Roderick has thrown more light than any man, either dead or alive. After long, unwearied labour, and with a fixed determination, he has arrived at the same result as to the protozoic epoch as the immortal Cuvier had done before him with the tertiary epoch.

To be the discoverer and the historian of a period of the world's history when the first organic beings were called into existence on our habitable globe, is surely what any man would be proud of. But our intellectual and noble veteran has still a good deal to do before he completes his picture of the Ancient Siluria. He has to give us a better notion of the ancient Silurian meteorology and climate—of the probable amount of solar heat required at that time for the development and growth of the vegetable and animal organic beings—and laws of geographical distribution. Such kind of knowledge is necessary to enable us to arrive at correct conclusions. We have, during the present period, many changes taking place, the conclusions in regard to which would certainly be incorrect if we were guided simply by the law of deposition. For example, we find, on a tropical coast, strata deposited daily from one of the great rivers;

but along with the alluvia is deposited not only plants and animals of the surrounding country, but also plants and animals brought down from the snowy heights by the same river. Similar strata found in a fossil state would undoubtedly lead the palæontologist to draw erroneous conclusions in regard to the climate of the period. We might give similar examples, produced by the Gulf Stream, and also by glaciers, icebergs, and great inundations passing from one country to another. May not some of our present fossils that are found under a totally different climate from that under which they lived, be accounted for in this way ?

Our earth was formed according to fixed and definite laws. Its rocks, minerals, and fossils have a definite structure, and a fixed position; therefore, erroneous theoretical conclusions must ultimately be overturned by the true philosopher.

The importance of a correct classification and a standard nomenclature, all must admit of—we mean a classification that will bear the surest of all tests—universality—a classification that will show us that the work of Nature is one great plan. It is only on some of the minor subdivisions of the formations that diversity of opinions among geologists exist; all agree on the main principles of classification—on the stratified and unstratified rocks, on the fossiliferous and non-fossiliferous, on the great divisions of the formations and their relative age, derived from a knowledge of superposition and organic remains. Our geological systems of classification have undergone a gradual improvement for many years, having passed through the hands of Werner, Macculloch, Conybeare, Al. Brongniart, Omalius, D'Halloy, De la Beche, Buckland, Mantell, Phillips, Sir Charles Lyell, the Rev. A. Sedgwick, and Sir Roderick Murchison. We still require much accurate knowledge for laying down correct boundary lines of our classification.

The azoic rocks demand much patient investigation in regard to the laws of deposition before we can expect to arrive at correct information in regard to the age of these non-fossiliferous strata.

But ere long we will arrive at as fixed and definite *arrangement* of these rocks as we now have of the protozoic, and we shall find that the strata are arranged in a definite order.

That the whole crust of our earth has been undergoing a metamorphic change from the beginning of time, there appears to be little doubt; but the cause of its apparent more or less activity, as observed by the geologist in the structure of rocks of almost every line of country over which he travels, is still a mystery, and can only be settled by a close chemical and microscopical examination of the rocks.

The relations of the sedimentary and Plutonian rocks are far from being properly understood. The general received notion that the Plutonic rocks, in a state of igneous fusion, were impelled from below against the strata that contorted them, fractured them, and filled up the spaces which they now occupy, appears not to be invariably correct, because we frequently find great tracts of country traversed in every direction by Plutonic agents without any change whatever being produced. "Let it, however, be understood," says Sir Roderick Murchison, "that the prodigious extent to which the metamorphism of the original strata has been carried in mountain chains, and at different periods through all formations, though often probably connected with such igneous outbursts, must have resulted from a far mightier agency than that which was productive of the mere eruption of molten matter or igneous rocks. The latter are, in fact, but partial excrescences in the vast spread of the stratified crystalline rocks—symptoms only of the grand changes which resulted from deep-seated causes, probably from the combination of heat, steam, and electricity, acting together with an intensity very powerful in former periods." *

We are still in want of correct information in regard to the origin of stratification, lamination, different kinds of structure, seams, joints, cleavage planes, and metamorphic action; we do not know if these changes are to be ascribed either to aqueous, igneous, or electric agencies, or molecular attraction, as connected with concretionary structure.

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* Murchison's Siluria, p. 4.

Much has been written on the metamorphic changes of rocks, but very unsatisfactory information has been arrived at. We still cannot tell how it happens that chalk, limestone, shale, sandstone, and coal, when traversed by granites, porphyries, and trap rocks, are changed into crystalline limestone, siliceous slate, quartz, and coke, at one time; and how, when in contact with the same Plutonian and trap rocks at another, produce no effect whatever.

We regret much we have not space in the present number of our Journal to give an outline of the novelties Sir Roderick has introduced into his new work, entitled Siluria—a most elaborate work, which consists of 523 pages, containing 163 woodcuts, 37 plates, and 2 maps. It is a faithful outline of Sir Roderick's previous labours, with a detailed description and condensed practical popular view of the older sedimentary rocks, and their characteristic organic remains, including all the most recent information on this subject. It is to the protozoic series of former accumulations, and the creatures entombed in them, that Sir Roderick's attention is more particularly directed. Sir Roderick brings out, with very strong and conclusive evidence, that the Silurian System is an independent system, a system that appears to have been formed in various parts of the globe at one and the same time, formed of the same rocks and minerals, and inhabited by the same animals and plants; and Sir Roderick maintains that the animals and plants found in the Silurian strata of the different quarters of the globe are not only analogous, but identical.* We are in want of sufficient data to enable us to say much in regard to the meteorology and hydrology of that early period. The higher temperature, which must have then prevailed all over the globe, appears to have been derived from the internal heat, and not the solar heat. We learn from the late palæontological researches, that nearly one hundred species of fossils are common to the lower and upper divisions of the Silurian System. Sir Roderick has established his Silurian system with uncontrovertible evidence in Great Britain and Ireland, Germany, France, Belgium, North America, Spain, Portugal, Sardinia, Cape of Good Hope, Himalaya Mountains, Hindostan, Australia, South America, United States, Falkland Islands, &c.

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* Such a conclusion cannot be held as correct, until we have acquired more accurate data of the biological character of the different epochs, as well as the *local faunæ* of the periods.

We now give several extracts from the concluding remarks of Sir Roderick's work, written in a highly popular and graphic style, and we are sure that our general readers will not only be much delighted, but edified, with what follows, and hope it will induce many to study the work.

" Passing rapidly over the earliest stages of the planet, which are necessarily involved in obscurity, our sketch of ancient nature began with the first attainable evidences of the formation of sediments composed of mud, sand, and pebbles. It was shown that the lowest accessible of these deposits, though of enormous dimensions, and occasionally less altered than strata formed after them, are almost entirely *azoic*, or void of traces of inhabitants of the seas in which they were accumulated. One solitary genus of zoophytes has been alone detected in most bottom rocks, the heat of the surface during these earlier periods having been, it is supposed, adverse to life.

" Proofs were then adduced to demonstrate that in the next formations, scarcely differing at all in mineral character from those which preceded them, observers in various regions had detected clear and unmistakable signs of a contemporaneous appearance of animal life, as shown by the presence of a few genera of crustaceous mollusks and zoophytes, occupying layers of similar date in the crust of the earth. Proceeding upwards from this protozoic zone, wherein organic remains are comparatively rare, we then ascended to other sediments, in which, throughout nearly all latitudes, we recongise a copious distribution of submarine creatures, resembling each other very nearly, though imbedded in rocks now separated by wide seas, and often raised up to the summits of high mountains. Examining all the strata exposed to view that were formed during the first long natural epoch of similar life termed Silurian, we found that the successive deposits were charged with a great variety of forms—of the trilobite, a peculiar crustacean—of the orthoceratite, the earliest chambered shell—as well as with numerous exquisitely formed mollusks, crinoids, and zoophytes; the genus graptolite, of the latter class, being exclusively found in these Silurian rocks. In short, my contemporaries have assembled from those ancient and now desiccated marine sediments, or repositories of principal creatures, examples of every group of purely aquatic animals, save fishes. The multiplied researches of the last twenty years have failed to detect the trace of a fish amid the multitudes of all other marine beings in the various sediments which constitute the chief mass of the Silurian rocks. Of these, though they are the lowest in the scale of the great division *vertebrata*, we are unable to perceive a vestige until we reach the highest zone of the Upper Silurian, and are about to enter upon the Devonian period. Even on that horizon the minute fossil fishes, long ago noticed by myself, are exceedingly scarce, and none have since been found in strata of higher antiquity. In fact the few fragments of cartilaginous ichthyolites of the highest band of Silurian rock still remain the most ancient known beings of their class.

"Looking, therefore, at the Silurian system as a whole, and judging from the collection of facts gathered from all quarters of the globe, we know that its chief deposits (certainly all the lower and most extensive) were formed during a long period, in which, while the sea abounded with countless invertebrate animals, no marine vertebrata had been called into existence. The Silurian (except at its close) was, therefore, a series in which there appeared no example of that bony framework of completed vertebræ from which, as approaching to the vertebrate archetype, the comparative anatomist * traces the rise of creative power up to the formation of man.

"Whether, therefore, the term of 'progressive' or that of 'successive' be applied to such acts of creation, my object is simply to show, upon clear and general evidence, that there was a long period in the history of the world wherein no vertebrated animal lived. In this sense, the appearance of the first recognizable fossil fishes is as decisive a proof of a new and distinct creation as that of the placing of man upon the terrestrial surface at the end of the long series of animals which characterize the younger geological periods.

"Nor have we been able to disinter from the older strata of this long period of invertebrate life any distinct fragments of land plants. But just in the same stratum wherein the few earliest small fishes have been detected, there also have we observed the first of a diminutive, yet highly organized, tree vegetation.†

"If it be granted that the position of the earliest recognizable vertebrata is good positive evidence on which to argue, still it might be contended that such forms may at a future period be found in the lower strata. In this work, however, I reason only on known data. Nor is it on this testimony alone, strong, clear, and universal as it is, that my view is sustained; for as soon as we pass into the formation immediately overlying, and quit the zone wherein the first few small fishes are to be detected, we are furnished with collateral proofs that this was the earliest great step in a progressive order of creation. In the following or Devonian period, we are surrounded by a profusion of larger fossil fishes, with vertebræ for the most part very imperfectly ossified, and with dermal skeletons of very singular forms, all differing vastly from anything of their class in existing nature. These fishes were thus clearly added to the other forms of marine life. Again, in this Devonian era we are presented with well-defined land plants, also of much larger dimensions than the very rare specimens in the uppermost Silurian, while towards the close of the period we meet with an air-breathing reptile. The little telerpeton had groves of tree-ferns or lycopodiaceous plants, and even of coniferæ, amid the roots of which he could nestle.

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* "See Owen on the Homology of the Vertebrate Skeleton, Reports Brit. Assoc. Adv. Sciences, 1849, p. 169. The general reader will find a powerful essay, embodying the opinions of the same high authority, on the proofs of a progression in creation, Quarterly Review, 1851, p. 412, *et seq.* The arguments there employed have been strengthened by subsequent discoveries alluded to in this volume. I would also specially refer the reader to Professor Sedgwick's Discourse on the Studies of the University of Cambridge, for a masterly and eloquent illustration of several of the views which are here advocated."

† Sir Roderick has long known the existence of bitumen and anthracite in the oldest greywacke or the Longmynd rocks, and considers that these substances might have been derived from masses of sea-weed; and it appears that Professor Nicol detected, under the microscope, a tubular fibrous structure in the ashes of anthracite. Anthracite has been discovered in the old greywacke of Cavan, Ireland, by Mr John Kelly.

"Just as the introduction of cartilaginous fishes (onchus, *e.g.*) is barely traceable at the close of the long Silurian era, so, becoming soon afterwards more abundant, they are associated in all younger formations with true osseous fishes, whose remains are found intermixed with the other exuviæ of the sea. Putting aside, therefore, theory, and judging solely from positive observation, we may fairly infer—*first*, That during very long epochs the seas were unoccupied by any kind of fishes; *secondly*, that the earliest discoverable creation of this class had an internal framework almost incapable of fossilization, and so left in the strata their teeth and dermal skeletons only; and *thirdly*, that in the succeeding period the oldest fishes having bony vertebræ make their scanty appearance, but become numerous in the overlying deposits. Are not these absolute data of the geologist clear signs of a progress in creation?

"In like manner, there is a progress in the productions of the land, the great carboniferous period being marked by the first copious and universally abundant terrestrial flora, the prelude to which had appeared in the foregoing Devonian epoch. This earliest luxuriant tree vegetation, the pabulum of our great coal-fields, is also specially remarkable for its spread over many latitudes and longitudes, and together with it occur the *same common species* of marine shells, all indicating a more or less equable climate from polar to intertropical regions, a phenomenon wholly at variance with the present distribution of animal or vegetable life over the surface of the planet.

"Lastly, while the Permian era was distinguished by the disappearance of the greater number of the primeval types, and by essential modifications of those which remained, it still bore a strong resemblance, through its plants and animals, to the Carboniferous period; whilst, in unison with all the great facts elicited by our survey of the older strata, it was marked by the appearance of an animal of a higher grade than any one in the foregone eras—a large thecodont reptile—allied (according to Owen) to the living Monitor.

"In speaking of the Silurian, Devonian, Carboniferous, and Permian rocks, let me however explain, that whilst each of the three latter groups occupy wide spaces in certain regions, no one of them is of equal value with the Silurian, in representing time or the succession of animal life in the crust of the globe. When the Silurian system was divided into lower and upper parts, our acquaintance with younger formations simply sufficed to show a complete distinction between its animal remains as a whole and those of the carboniferous rocks, from which it is separated by the thick accumulations of the Old Red Sandstone. At that period the shelly, slaty rocks of Devonshire, were not known to be the equivalents of such Old Red Sandstone; still less had the relations and lime contents of the strata now called Permian been ascertained. Judging from the fossils then collected, it was believed, that the Lower Silurian contained organic remains, very distinct from those of the Upper Silurian; and yet the two groups were united in a system, because they were characterised throughout by a common *facies*. This so called system was, in short, typified by a profusion of Trilobites and Graptolites, with Orthides and Pentameri of a type wholly unknown in the carboniferous rocks. And whilst fishes were seen to exist in the intermediate masses of Old Red Sandstone, no traces of them could be detected below the very uppermost zone of the Silurian rocks. Nineteen years have elapsed, and after the most vigilant researches in various regions of both hemispheres, these great features remain the same as when first indicated. The labours, however, of those who followed me, have infinitely more sustained the unity of that system,* for its lower and upper divisions are now proved to be connected, not only by such generic types and analogous forms, but further by the community of a very considerable number of identical bodies.

"In a broad classification of primeval life, one eminent naturalist† views the Devonian, Carboniferous, and Permian rocks as simply the Upper Palæozoic; the Silurian rocks constituting the Lower

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* See the works of John Phillips, E. de Verneuil, Edward Forbes, Joachim Barrande, James D. C. Sowerby, James Hall, J. W. Salter, D. Sharpe, T. Davidson, John Morris. The most recent researches in Britain give the large number of nearly 100 species of fossils, common to the Lower and Upper Silurian.

† Edward Forbes.

Palæozoic. But, whether this ancient series be divided into double or triple classes (some palæontologists preferring to hold the Devonian as a separate and intermediate type), the result of the researches of the numerous authors appealed to in this volume has unquestionably justified the application of the term 'system' to the Silurian rocks.

"At the close of the Permian era, an infinitely greater change took place in life than that which marked the ascent from the Silurian system to the overlying groups. The earlier races then disappeared (at least all the species), and were replaced by an entirely new creation, the generic types of which were continued through those long epochs which geologists term secondary or menzoic, (the medieval age of extinct beings). In these, again, the reader will learn by consulting the works of many writers, how one formation followed another, each characterized by different creatures; many of them, however, exhibiting near their downward and upward limits certain fossils, which link on one reign of life to another.

"In surveying the whole series of formations, the practical geologist is fully impressed with the conviction, that there has, at all periods, subsisted a very intimate connection between the existence, or at all events the preservation of animals, and the media in which they have been fossilized. The chief seat of former life in each geological epoch is often marked by a calcareous mass, mostly in a central part, towards which the animals increase from below, and whence they diminish upwards. Thus, the Llandeilo limestone of the Lower Silurian, and the Wenlock of the Upper Silurian, are respectively centres of animalization of each of those groups. In like manner, the Eifel limestone is the truest index of the Devonian; the Mountain limestone of the Carboniferous; and the Zechstein, or English Magnesian limestone of the Permian. Throughout the secondary rocks the same law prevails more or less; and wherever the typical limestone of a natural group is absent, there we perceive the deposits to be ill characterized by organic remains. For example, the Trias, so rich in fossil contents where its great calcareous centre the Muschelkalk is present, as in Germany and France, is a miserable sterile formation in Britain; where, as in our own new Red Sandstone, no such limestone exists.

"Among the terrestrial changes to which science clearly points, there is no one which better deserves to be recorded in a few parting words, than that great mutations of surface and its accompanying loss of warmth, by which extensive fields of ice were first formed upon the sea, and large glaciers upon the land. As very lofty mountains in moderate latitudes, and masses of land and water in Arctic or Antarctic regions, are now essentially the seats of glaciers and icebergs; so we know that these bodies alone have the power of transporting huge erratic blocks from their native mountains to considerable distances by land, or for hundreds of miles over the sea in floating icebergs. Now, of the translation of such blocks we have no evidence whatever in any former geological period! On the contrary, whilst every boulder of the primary, secondary, or older tertiary rocks bears on its surface the signs of having been winter-worn, or rounded by aqueous or atmospheric agency; the great blocks of the later cold period, (gigantic in comparison with all that preceded them), are often angular, or nearly in that state in which they left the mountain side, before, in short, they were wafted over seas or lakes, to be dropped, at remote distances from their parent rocks, upon sediments which, by subsequent elevation, have been made portions of our continents. Hence, independently of the indications of a more equally diffused and warmer temperature in olden times than at the present day, these large erratics are in themselves decisive testimonials of that intense cold which, it is believed, was principally due to the great, elevated masses of land, which specially characterize the modern period.

"Receding backwards from this general phenomenon, which, continuing into our own times, has been so skilfully illustrated by eloquent writers, it is specially my province to endeavour to impress upon the reader the importance of endeavouring to form an estimate of the physical geography of the earth, during those remote periods when the Palæozoic deposits were accumulated. If very lofty mountains did not then exist, we have indeed, in this single phenomenon, what may have been one of the chief causes of that equable and warm climate, so indispensably requisite to harmonize with the facts recorded in this volume. And if we add the inference adopted by many philosophers and geologists, that the earth, in cooling down from its original molten state, must, during long succeeding ages, have diminished in heat over its whole surface, we are enabled, by reference to physical changes alone, to satisfy ourselves that we have in them the chief elements required to explain all climatal results.

"From the effects produced upon my mind through the study of these imperishable records, I am, indeed, led to hope that my readers will adhere to the views which, in common with many contemporaries, I entertain of the succession of life. For he who looks to a beginning, and traces thenceforward a rise in the scale of being, until that period is reached when Man appeared upon the earth, must acknowledge in such works repeated manifestations of design, and unanswerable proofs of the superintendence of a Creator."

NOTE.—We annex the following valuable table of the divisions of the older Rhenish rocks, as now understood by the geologists and palæontologists cited in the pages of Sir Roderick Murchison's work, and whose discoveries, coupled with Sir Roderick's recent observations, have led him to divide the Devonian rocks of the region into three parts. By having alongside of this table the general succession of some rocks as classified by M. Dumont, the reader will at once see that although the mineral order, which that author indicates, is doubtless *correct*, no one of his three terrains is in unison with a classification based *upon the* distribution of organic remains.

CLASSIFICATION OF M. DUMONT.			CLASSIFICATION ADOPTED IN SIR RODERICK MURCHISON'S SILURIA.						
errains.	Systêmes.	Lithological Divisions.		Fossiliferous Divisions.	Localities in Prussia.	German Names.		Geological Groups.	Classes.
ANTHRAXIFERE.	Houiller.	Ampēlite, Psammite, Schiste, Houille.	Upper Carb.	Coal Measures, *i.e.* Shale, Sandstone, and Coal.	Werden, Herdecke, &c. (Westphalia).	Stein-Kohl Formation.	Jungere Grauwacke.	Carboniferous.	UPPER PALÆOZOIC.
			Lower Carboniferous.	Millstone Grit, &c.	Schwerte, Menden (base of Coal-fields).	Fletz-lehrer Sandstein or Jungste-Grauwacke.			
	Condrusien.	Calcareux—Calc. à Crinoides et à Productus, Dolomie, Silex, Anthracite.		Carboniferous Mountain or Productus Limestone. (Culm Limestone, with Posidonomya Becheri).	Ratingen (Cromford), Arnsberg, Herborn.	Berg-Kalk and Posidonomya Schiefer.			
				Limestone, Shale, and Sandstone.	Schelke, Langescheid.	Kiesel-Schiefer, Pön Sandstein, &c.			
		Quartzo-Schisteux supérieur. Psammite grisâtre, Macigno, Anthracite. Schiste grisâtre, Calc. Schiste, Calcaire Oligiste oolitique.	Upper Devonian.	Schists and nodular Limestone, with Clymeniæ, Cypridinæ, &c.	Mecklinghausen, Laasphe (Westphalia). Weilburg and Selters (Nassau).	Kramenzel-stein, or Cypridina-Schiefer.		Devonian. (Old Red Sandstone).	
	Eifelien.	Calcareux. Calcaire et Dolomie.		Schists with Goniatites retrorsus.	Meschede, Nuttlar (Westphalia).	Flint-Schiefer.			
		Quartzo-Schisteux inferieur. Schiste gris fossilifère, Calc. Schiste et Calcaire-argileux, Oligiste oolitique. Poudingue. Psammite et Schiste rouge. (Pepinster.)	Middle Devonian.	Great central Coralline Limestone with Stringocephalus Burtini, Megalodon cucullatus, and the chief Devonian types. Schists and Grauwacke Sandstone, with Calceola sandalina.	Eifel and Paffrath, Brilon, Limburg, Iserlohn, &c. (Westphalia). Cubach (Nassau). Escarpments of the Eifel Limestone and banks of the Ahr, left bank of Rhine. Agger-thal and banks of river Lenne, right bank of Rhine.	Eifel-Kalkstein, or Stringocephalus-Kalk. Calceola Schiefer, or Agger and Lennegruppe (von Dechen).			
RHÉNA	Ahrien.	Grès, Psammites et Schistes, gris-bleuâtres.							
	Coblentzien.	Grès et Phyllades, gris-bleuâtres.	wer onian.	Wissenbach Slates, Caub Slates, &c. Coblentz Grauwacke (Spirifer Sandstone). with Spirifer Macronte-	Wissenbach, near Dillenburg and south flank of the Taunus	Wissenach Schiefer.			

Notice of some Ancient Indian Mining Tools, found in the Copper Districts of Lake Superior.

BY WILLIAM JORY HENWOOD, F.R.S., F.G.S., Member of the Geological Society of France; Corresponding Member of the Lyceum of Natural History, New York.

Although the existence of native copper on the shores of Lake Superior has long been known, its abundance has been but lately discovered by the present inhabitants. It was, however, extensively wrought by the ancient population; although no tradition relating to it remains amongst existing Indian tribes. So remote indeed was the period, that the oldest and largest trees of the forest have grown indifferently on and beside the old excavations. Few of these are found open; for the primitive workmen seem not to have lifted their rubbish to the surface, but to have thrown it behind them; thus filling their abandoned workings as they proceeded. The operation of obvious influences during the lapse of time has caused the loose stones and earth to pack more closely; and thus to form those depressions of the surface which the sharp-eyed American explorers soon found to mark, very frequently, the sites of ancient Indian copper-mining; many of which have been lately re-opened. Traces of copper have been found in them all; but the only instance in which riches were discovered, was one in which the mass of metal was about ten feet long, three feet wide, nearly two feet thick, and the weight more than six tons, on which the feeble means at command probably produced but little effect.[*]

Amongst the rubbish so economically disposed of, thousands of stone hammers have been found; sometimes singly, but more commonly great numbers of them together. The one I have the honour of presenting to the Institution herewith, I took from a heap of about a wheelbarrowful, which I found lying on the brink of one of the lately reopened excavations near Eagle River in Michigan. It seems of siliceous sandstone, containing a few flakes of mica; and is the hardest stone I found in the neighbourhood. It will be found to present a rude edge at either end, and to be grooved round the middle, for the reception probably of the *withe* which served as its hilt. The splinters which have been split from it were, it seems likely, struck off in course of working.

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[*] "In the winter of 1847-8, Mr Samuel O. Knapp, the intelligent agent of the Minnesota Mining Company, found near the Ontonagon river a pit of twenty-six feet deep. At the depth of eighteen feet he came to a mass of native copper, ten feet long, three feet wide, and nearly two feet thick, and weighing over six tons. On digging around it the mass was found to rest on billets of oak supported by sleepers of the same material. The ancient miners had evidently raised it about five feet, and then abandoned the work as too laborious. They had taken off every projecting point which was accessible, so that the exposed surface was smooth."—(*Foster and Whitney's Report on the Copper-Lands of Lake Superior*, p. 159.)

I have had no means of comparing it with the stone *celts* which are not uncommon in collections of antiquities;[*] but if I correctly remember those I have seen—especially in the interesting antiquarian museum of Mr Lukiss of Guernsey—it has a rude, though not distant, resemblance to some of those obtained on the opposite coast of the channel.

These stone hammers are perhaps powerful enough for working the decomposing amygdaloidal trap-rock in which most of the copper occurs on the shores of Lake Superior; and numerous as they are, they are the only tools which have yet been found there. If any others existed, they are however probably made of wood; and the action of the influences already alluded to, during so long a time as must have elapsed since the earlier workings, would perhaps have sufficed for their destruction.

I should not have offered so meagre a notice to the Institution, but that I thought not devoid of interest in a mining district, a memorial, however slight, of the extraction of copper in so distant a country at so remote a period.

3 CLARENCE PLACE, PENZANCE,
August 19, 1854.

The Botany of the Eastern Borders, with the popular Names and Uses of the Plants, and of the customs and beliefs which have been associated with them. By GEORGE JOHNSTON, M.D., Edinburgh. London: John Van Voorst, Paternoster Row, 1853.

It is well for science that the author of the volume before us has thought fit, in the autumn of a busy life, to embody his researches in the natural history of his native district. In the preface the object of the work is concisely stated. A catalogue of its organic productions has been made as complete as possible; their limits of distribution and comparative abundance have been noted; the importance of giving the local or provincial names of natural objects as tending to throw

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[*] During the present summer I have seen many stone *celts* in Jamaica. They seemed to consist of a very fine-grained and hard greenstone. Locally they are called "*thunderbolts*."

"a faint light on the characteristics and descents of the people," and of recording the fragments of the simpler's lore, and dispensatory of our native plants which are fast fading into oblivion, is enforced with a quiet engaging earnestness. In the introductory chapter the district is defined as comprehending the whole of Berwickshire, the liberties of Berwick, and the immediately adjacent parts of Northumberland and Roxburghshire; it embraces an area of about 700,000 acres, of which about one half is arable, and the other half is hill pasture, or moor. The sea constitutes its boundary on the east, whilst on the other sides it is surrounded by high grounds of more or less elevation, where the Cheviots and the Lammermoors are the principal. Its fitness for the vocation of the naturalist is amply illustrated in the accompanying short descriptions of its hills, valleys, deans, lakes, and streams, both in their individual character and as component parts in the landscape; for, to use the author's own words,—

> "I could not fail, at the same time, to discover its many pastoral —its many sylvan—its many landscape beauties, which lie hid amidst its hills and deans, and hard by its waters. And there was the additional attraction of visiting spots which have been made for ever eloquent by the events of which they are the monuments; for the district is indeed rife with places that derive interest from historical recollections—with everlasting hills whence arose the smoke of druidical sacrifices—with rills whence was lifted the water of the baptism of the first converts to our Christianity—with cairns, camps, and seats of regal and lordly power—with ancient priories, and cells, and abbeys, that are still our admiration—with battlefields of note—with strong castles, and towers, and bastiles—with fairy traditions and love passages—with much poetry and romance —with the birthplaces of men who have risen above common humanity."

Yes, truly we may say,—

"Nullum sine nomine saxum."

The deep, narrow glens, locally termed deans, are a very striking feature in the physical aspect of the district, and it is with pleasure that we quote in part a description of one of them as a favourable specimen both of our author's powers of description and of observation:—

"The water has got increase, and has more force and velocity, and it runs impatient in its rough channel. Hazle mingles with the willows, wild roses and brambles entangle the brake, a copsewood of sloe-thorn occupies the top of the bank, succeeded by a space covered by the braken; and the opposite north bank bears a cover of the whin, gemmed with the herblets (Stellaria graminea, Orobus tuberosus, &c., &c.), which delight in its shelter, and run up amidst its branches. This is a pleasant spot, full of botanical riches; and we leave it with regret, for the steep banks that succeed are planted with wood—with beech, elm, and plane-tree, and with a few Scotch firs. There is not much here to interest us; but as we emerge from the shade of this plantation, the banks nigh each other and their fronts become rocky and abrupt, and form a narrow passage through which the water must force itself. This it does in a rumbling fashion. It falls first over a linn about a yard in height into a circular caldron of pure water; and then it hurries away in a troubled stream, leaving on one side a little gravelled edge, and running on the other under a projecting ledge. Ferns from both sides, and from every crevice, overhang the darkened chasm. Above, the polypody leans over the bank in a dark green fringe; below, tufts of Aspidium lobatum project from under shelving rocks, and the little elegant Asplenia hang out their pretty fronds everywhere, and in a manner that no pencil can delineate. The lady-fern grows here in large tufts; and the Aspidium dilatatum is sure to be looking out alongside of its narrow fronded ally. The botanist lingers here long; there is much for his study, and for his admiration. When at length he emerges from the gloom, he finds on one side an old quarry not without its peculiar interest. The bottom is rough, with broken stones grown over with docks and nettles; in a corner there is a thicket of sloe-thorn, with a glorious bed of Stellaria Holostea; at the base of the rock's face are tufts of the male fern and Aspidium dilatatum; and the chinks of the face itself tufts of the blue-bell, the stately fox-glove, the showy viper's bugloss and a hanging bush of the whin, one mass of gold in its season. Follow the burn no further, for here it loses the dean, and pursues its future course through cultivated fields that vary their character yearly at man's will."

No wonder, then, that the man who penned such like transcripts on Nature's solitudes, should love the modest drooping wood-sorrel above all other flowers!! In our author's description of Horncliff, and of the Berwickshire Naturalist Club meeting at Etal, we obtain a still more extensive insight into the more characteristic aspects of the vegetation of the Borders under varying circumstances, as well as of the genial character of the meetings of that club, which has been the parent of all similar societies in Great Britain.

This volume is restricted to the botany of the district; it contains a lecture on "Our Wild Flowers in their relations to our Pastoral Life," replete with much that relates to the amusements of childhood, the popular beliefs, the gentler, and the darker love passages of the district, the trysting-trees, and the reputed haunts of the fairies and witches of the olden times. All the gentler feelings and associations with flowers are linked together in the story of the chequered fortunes of a peasant family; sentiments which will find an echo in every thinking bosom are wedded to some extracts from the best poetry of England and Scotland. There exists a pretty general prejudice against the very name of a local flora; for in too many instances the descriptions of species, references to figures, and lists of synonymes, have merely been copied from other works. About twenty years ago, the author published a "Flora of Berwick-upon-Tweed," with original descriptions of all the species, and, independent of its other merits, it occupies a position in the list of our local floras, which perhaps has only been approached by Greville's Flora of Edinburgh. Now that we are provided with the critical and standard British Floras of Babbington, and Messrs Hooker and Arnott, our author has done well to adopt the nomenclature of the two last-mentioned authors, and to discard all descriptions, except a few original ones on the genus Rubus, and a few others. We believe that botanists in general will not only ratify this wise decision, but approve of the general plan of the work:—First, a defined area; second, a full list of species; third, the relative scarcity or abundance of each species; fourth, the time of flowering, and station; fifth, the general distribution of each species, and the localities of the rarer ones; sixth, the order in arrangement and precision in nomenclature approved of, or at all events known to botanists in every quarter of the world. Upon this solid foundation the author has built a short natural history of all the more interesting species, the popular names, and the uses, customs, and beliefs which have been associated with them. This will form the chief attraction for the general reader, as well as for the more philosophically-minded student.

If we agree in acknowledging that the poet hath well said—

> "It is the soul of man, with its hopes and its dreams,
> Which lights up all Nature with living gleams;"

if we would endeavour to master the purpose for which this work was planned, and to comprehend the spirit in which it has been executed, it may be useful to inquire into the origin of the inhabitants of the district, and the more striking changes which have occurred in their social condition.

Previous to the Roman Conquest in A.D. 80, little was known of the history, civil or religious polity, of the race; no sculptured stones or storied bricks have ever been found; nothing but weapons of stone, of bronze, and, lastly, of iron, remain to attest the slow progress of a rude people towards a higher stage of civilization in the arts relating to the chase and to war. Roman chroniclers inform us that the original inhabitants belonged to the Celtic race, and that they were divided into various independent tribes, each governed by an hereditary chieftain. This peculiar institution flourished along the Scottish Border for centuries after the race had succumbed before the Saxon colonists, and long after these, in other districts, had bowed their sturdy necks to the feudal laws of the haughty Normans. After the withdrawal of the Roman legions in A.D. 426, the incipient civilization of the Romanised Britons disappeared before the incursions of the unconquered tribes of the North, and these in their turn gave way to the influx of Saxon colonists in 449. Early in the seventh century the land was subdivided and populous; but in the following century, and down till 934, all this fair prosperity was blasted by the incursions of the ferocious Danes; a proportion of the latter amalgamated with the inhabitants; at a later period a few Norman chiefs appeared; and thus the Borderers by descent are pre-eminently a mixed people. The Tweed and the Cheviot Hills were constituted political boundaries in 1018, when the Earl of Northumberland ceded Berwickshire to Malcolm II. of Scotland. During that and the following century considerable progress was made in civilization; but the long and bloody wars attending the disputed succession to the Scottish throne gave an impetus to the barbarous system of warfare, which, in defiance of all international law, raged for centuries along the Borders. The chase and war were deemed the only occupations worthy of a man. Where the law of the sword alone prevailed, the very worst passions of our nature were engendered, and selfishness rode triumphant over all; even patriotism burnt with a flickering light, when the safety of a chief or the aggrandisement of a clan were concerned.

Previous to the embodiment and recognition of civil law, when might was right, religion was the sole controlling power, and, besides the military chiefs, its priests alone exercised any influence for moral good, and for uniting the various tribes in some common cause. Amongst the ancient Britons, the ranks of the priests were recruited from the noblest families; their education, which often extended over a period of twenty years, comprehended the whole of the sciences of the age; and, besides their sacred calling, they were invested with power to decide civil disputes. Their dwellings and temples were situated in the thickest oak groves, which were sacred to the Supreme Deity. The acorn, and above all the parasitical misleto, were held in high veneration; and the latter was sought on the sixth day of the moon, and when found was only cut by a priest of the highest rank, for it was accounted a sovereign remedy for all diseases. The practice of the healing art has ever commanded the esteem of the rudest nations; hence it was the obvious policy of the priests, or Druids, to study the properties of plants. Of their progress we have no record; but who knows from what a far antiquity comes the traditionary virtues of many of our native plants? As we cannot ascertain how much of this kind of knowledge we owe to the Saxons, it might be instructive to know how much we possess in common with the present inhabitants of northern Germany and of Scandinavia.

Early in the seventh century, the disciples of Columba, from Iona, first preached the gospel with success amongst the barbarous Pagans who then inhabited the district. Their loving zeal for the truth was wrapped up in an anxious desire to promote the happiness of their people; but after a time their good work was marred by incursions of the Northmen, and latterly they were driven out of the district by the machinations of the Romish missionaries. That Church was a thoroughly compact body, and its principles were antagonistic to the spirit of military violence which characterized those ages. Within its pale were preserved and cherished those precious remains of ancient literature, science, and art, which had been rescued from the havock of the inroads of the barbarians. Within its bosom, in the various grades of the priesthood, were to be found men whose natures were too gentle to cope with the spirit of those iron times, and stern natures that had grown sick of the mortal strife. Great was its moral and social influence, for the rudest warrior respected the sanctity of the altar, and trembled at the churchman's frown. Wells of medicinal repute, situated hard by the old sacred groves, and whose virtues were attributed to some presiding deity, were dedicated to some favourite saint; and several plants were in like manner dedicated to the Virgin Mary. The fields of the monks exhibited a style of cultivation worthy of the practical students of Virgil and Columella, and the poor were fed at a bountiful rate from their well-stored granges. The frequent fastings and abstinence from animal food led to the introduction from foreign lands of plants that were both useful and grateful to the palate. The attention bestowed by the clergy in ministering to the ailments of their people, were in like manner favourable to the progress of gardening. Previous to the ascendancy of the Church of Rome, in the physic garden of the Saxon age we find " peppermint, rosemary, sage, rue, pennyroyal, fenugreek, cummin, water-cress, cornflag roses, lovage, fennel, tansy, white lilies, kidney-beans, and savory; corianders and poppy were grown in the kitchen garden." At a later period, in monkish gardens might be seen " bluebells, bachelor-buttons, balm, daffodil, golden and silver-rod, honesty, lily of the valley, marigold, mint, narcissus, Solomon's seal, southernwood, and Star of Bethlehem." Our author gives a quotation to show that above three hundred species of " medicinal plants were known to the monks and friars, and used by the religious orders in general for medicines." The evidence of the learned Chalmers is adduced to show, that in the thirteenth and fourteenth century every house in the Border towns and villages had a garden "for raising culinary herbs;" and we most cordially agree with our author, that a good history of monkish botany would prove invaluable for settling disputes about certain indigenous and naturalized plants.

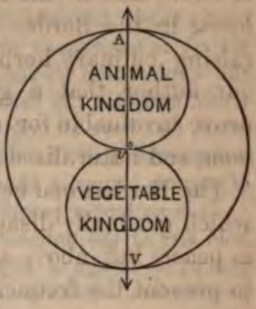
The Borders had been originally covered with noble forests, which gradually disappeared before the improvident waster in peace, but, above all, by the havock of contending armies to prevent the frequent ambuscade of foes. Thus, in course of time, the whole country was bared to the sweep of the winter's blast; bogs filled up the valleys, gendering unwholesome exhalations; the crops were scanty and late; severe famine for both man and beast were of frequent occurrence. The Reformation swept away all monkish establishments. In the day of distress there were no well-stored granaries for the famished, no medicines for the afflicted; yet some knowledge of medical botany lingered amongst the people, and was cherished in simple faith down to these latter days, and even yet it lingers amongst the unlearned in retired places.

(*To be continued in the next number of Jameson's Journal.*)

On the Manifestation of Polarity in the Distribution of Organized Beings in Time. By Professor E. FORBES.

Of the four relations among organized beings, viz.: Affinity (or relation through homology), Analogy, Representation, and Polarity, the three first have been recognized in the distribution of beings in Geological Time; the fourth has never been observed nor sought for. The term itself is one not familiar in the language of Natural History, although proposed many years ago by the Swedish botanist Fries, and systematically employed by several naturalists for some time past. The word Polarity seems objectionable, since it has been appropriated with a peculiar signification by Physical philosophers. The sense in which it is employed by Naturalists, that of a manifestation of force of development at opposite poles of an ideal sphere, cannot, however, be indicated by any other word at present invented, implying as it does something very different from *divergence* and *from antagonism*, words which have been suggested as substitutes.

The ordinary illustration of the relation of *Polarity*, in a natural history sense, is that representing the relation of opposition or progression in opposite directions of the Animal and Vegetable series; the meeting point of both being at the points of lowest development of each (*a*, *v*, in the accompanying diagram), where the animal and vegetable natures are almost confounded, whilst the strongest manifestations of each are at A and V, the highest animals being farthest removed from the highest vegetables,—in other words, at opposite poles of the sphere of organized beings.



The earnest desire implanted instinctively in every inquiring mind, to discover a law or scheme in arrangements of Nature, has given origin to many speculations concerning the distribution of life in geological time, all of them founded on facts more or less clearly understood. Hence have arisen the hypothesis of an evolution of all organized types, during the course of time, from one rudimentary prototype; that of the succession of distinctly originating forms of animals and vegetables in order of the progression within their respective series; of the coeval starting of the great groups wholly or mostly at the beginning, but in each instance by the lower forms of the type; of the representation by the faunas and floras of geological epochs; of the successive zones of life belting the geographical regions between the poles and the equator; of a uniformity of life arrangements throughout time and repetition through substitution of equal and similar groups; and of manifestations in the distribution of life in time of analogies that are essentially theological.

For several years I have been persuaded that the simple and unquestionable phenomena of substitution of groups by representative groups, manifested in the arrangements of the faunas and floras of all geological epochs, and comparable with like phenomena exhibited by the geographical distribution of existing organized beings, would prove sufficient for the explanation of all the appearances that have suggested such speculations, some purely hypothetical, some fairly theoretical, as those I have just indicated. The apparent contradictions and unexplained peculiarities presented by the more ancient epochs as contrasted with the middle and newer ones, seemed to depend on the incomplete state of our knowledge, and to be possibly explainable by supposing, that of some great geological epochs in time we had as yet discovered no traces. Thus the great gap between the Palæozoic and Mesozoic life might depend upon our not yet having discovered traces of the rudimentary formations that had been deposited during the interval between the Permian and Triassic epochs.

But the rapid accumulation of palæontological facts gathered within the last very few years, and the great additions that have been recently made towards our knowledge of the Palæozoic fauna, all mainly in accordance with facts known before, have satisfied me that the explanation offered above does not sufficiently meet the full truth, and that the various theories concerning progression, development, &c., have all originated in the obscure perception and imperfect interpretation of the workings of some great law in the distribution of organic beings in time.

It is no longer possible, in the face of palæontological evidence, to hold any of the notions cited. The scale of the first appearance of groups of beings of any degree is most clearly not one of organic progression. Suitable conditions have been met by the creation of suitable types; no type, whether generic and therefore ideally manifested, or specific and therefore manifested actually and through individuals, visibly, being found to be ever repeated in time, when the full history of either is made out. This is a great law, and a grand result of geological research. Nevertheless, in the relative arrangements, so to speak, of generic types in time, there is an indication of the working of a general law of another kind, and one which seems to me to depend on *the manifestation of the relation of Polarity*.

We are accustomed to group all geological epochs under three great sections, the Palæozoic or oldest, the Mesozoic or middle, and Cainozoic, more commonly termed Tertiary, or newest. If we consider the faunas and floras of these three great sections, we cannot but perceive that there is a far stronger affinity between the Mesozoic and Tertiary epochs than between the Mesozoic and Palæozoic. This is especially manifest when we regard the details of the distribution of those preservable forms of animal life, which being inhabitants of the medium in which sedimentary strata are deposited, are most likely to afford an approach towards complete evidence. On the other hand, the forms of life that characterize the Palæozoic formations, the products of a vast succession of time-periods, have, when regarded in their totality, a wonderful agreement and relationship among themselves.

For this reason I propose to denominate the sum of the epochs after the PALÆOZOIC, by the name of NEOZOIC.

Now if we regard these two great periods separately, we find that the manifestation of generic types during each exhibits striking and contrasting phenomena. *The maximum development of generic types during the Palæozoic period was during its earlier epochs; that during the Neozoic period towards its later epochs.* And thus, during the Palæozoic period, the sum of generic types and concentration of characteristic forms is to be observed in Silurian and Devonian formations; during the Neozoic period it is during the Cretaceous, *Tertiary*, and present (itself part of the Tertiary) epochs that we find the maximum development of peculiar generic types (or ideas). On the other hand, during the closing epochs of the Palæozoic and the commencing epoch of the Neozoic period there was a poverty in the production of generic ideas, with few exceptions the species of the epochs in question being members of genera that form constituents in the assemblage, accumulated during the epochs of maximum of generic types or ideas.

The following table may render my meaning more evident :—

Neozoic period.	Present and Tertiary epochs	Epoch of maximum development of Neozoic Generic types.
	Cretaceous epochs	
	Oolitic epochs	Intermediate.
	Triassic epochs	*Epochs of poverty of production of Generic types in Time.*
Palæozoic period.	*Permian epochs*	
	Carboniferous epochs	Intermediate.
	Devonian epochs	Epoch of maximum development of Palæozoic Generic types.
	Silurian epochs	

Before the Silurian and after the *commencement* of the present, no special creations of generic types have as yet been shown to be manifested. In the system of life of which all known creatures living or extinct as yet described, so far as our knowledge extends—and there is a consistency in its co-ordination that suggests the probability of our being acquainted with its extremes—the creation of the fauna and flora of the oldest Palæozoic epoch would seem to be the primordial, and the appearance of Man the closing biological events.

When the assemblage of characteristic Neozoic groups or genera is contrasted with that of the Palæozoic, there we find that the concentration of a maximum development of generic types towards the earlier stages of the one and the later of the other great period, includes something more than a mere numerical profusion of generic ideas. The two great manifestations of creative intensity are in opposition, or contrast, and respectively substitute each other; groups that are parallel within their sub-kingdoms or classes taking the place of each other, and playing a corresponding part in the economy of nature. This replacement does not depend on the substitution of a group of higher organization during the latter epoch, for one of lower during the former. Where there is such a substitution it must be regarded as an accident; for the rule is not general, nor can it be held good except for a few instances.

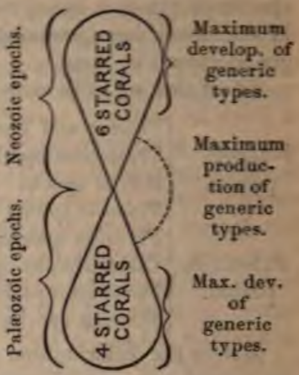
A few leading examples of the substitution of group for group during the contrasting epochs are cited in the following table, and will illustrate this point better than a mere abstract statement.

Neozoic.	Palæozoic.
Cycloid and Ctenoid Tubes	Ganoid and Placoid Tubes.
Malacostracous Crustacea	Entomostracous Crustacea.
Dibranchiate Cephalopoda	Tetrabranchiate Cephalopoda.

Lamellibranchiate Acephala	Palliobranchiate Acephala.
Echinoidea	Crinoidea.
6-starred Corals	4-starred Corals.

If we were to show by means of a detailed diagram the relations in each of these groups of the development of generic types to time, we should symbolise it by a cone or a pyramid, the base or fullest portion of which should be turned respectively towards the commencement of the Palæozoic, or termination of the Neozoic epoch. The last example given will show this strikingly, though in most instances the groups interlace.

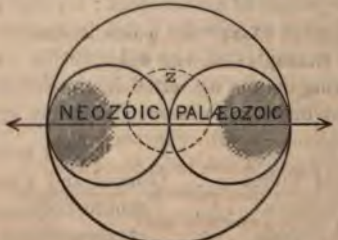
Relations of this kind may be manifested in a low degree, even within the range of a single group.


Neozoic epochs.
Palæozoic epochs.
6 STARRED CORALS
4 STARRED CORALS
Maximum develop. of generic types.
Maximum production of generic types.
Max. dev. of generic types.

From all these considerations, the numbers of species in a group or genus at any given epoch is to be excluded, not being an element in the discussion of the question, though apt to be introduced through mistake of the nature of the generalization attempted to be attained.

There may appear to be a contradiction involved in the expression *manifestation of polarity in time,* for since time implies sequence or progression in one direction only, how can we connect with time an arrangement that involves the notion of progression in opposite directions, proceeding from a median zero.

But time is an attribute with which man's mind invests creation; a mode of regarding Divine ideas, necessary for the conception of time by our limited faculties, and forming in itself no part or essence of the Divine scheme of organized nature. We speak of Polarity in Time, for want of a better phrase; but this polarity, or arrangement in opposite directions with a development of intensity towards the extremes of each, is itself, if I am right in my speculations, an attribute or regulating law of the divinely originating scheme of creation; therefore, strictly speaking, independent of the notion of time, though perceptible by our minds only in connection with it.



By a diagram such as the above we may fairly express this view, the shaded portions of the circles included within the great circle of the system of nature representing the maxima of development of generic ideas, and the dotted area, *z*, the region of their minimum productions.

In venturing on a speculation of this kind I am aware that it is subject to much misrepresentation and liable to be misunderstood; the more so since the suggestion must precede the demonstration. At present it can scarcely be received as more than a suggestion; one put forth as worthy of consideration. But in issuing it I do so keeping in view a vast number of individual facts, and base it upon the results of investigations of no small extent. To lay these before the scientific world in detailed and tabulated shape will be the work of more leisure than can at present be given to the task. In the hope of acquiring fresh data for this investigation, I, rashly as some may think, make public this hypothesis. That it is the only one of its class which holds out a prospect of eliminating the germs of truth contained in the conflicting theories at present more or less in vogue, and the only one with which the presence of species of any group of organized beings at any geological epoch will not disagree, are surely considerations that should secure for it a friendly reception. If it be as true, as I believe it to be, then the truth that it contains is most important; if it prove in the end to be a misinterpretation, it will at least have served the good purpose of stimulating inquiry in a fresh direction.—(*Proceedings of the Royal Institution, London.*)

Obituary of Dr Samuel George Morton.

America has sustained a very great loss from the death of the learned and highly accomplished Dr Morton. He belonged to the Society of Friends. His school education he complained much of. He had an early passion for poetical reading and composition—and many of his verses are considerably above mediocrity—for example, his "Spirit of Destiny."

"Spirit of Light! thou glance divine,
Of Heaven's immortal fire,
I kneel before thy hallowed shrine,
To worship and admire.
I cannot trace thy glorious flight,
Nor dream where thou dost dwell;
Yet canst thou guard my steps aright,
By thine unearthly spell.

> I listen for thy voice in vain,
> E'en when I deem thee nigh;
> Yet ere I venture to complain,
> Thou know'st the reason why.
> And yet when, worldly cares forgot,
> I watch the vacant air;
> I see thee not, I hear thee not,
> Yet know that thou art there."

He was the founder of the school of ethnology in America. His taste for natural science and for anthropology was acquired at the university here (Edinburgh); and he studied at a time when the university was in its glory, and was the centre of taste and philosophy, as well as of science, in Great Britain. He graduated here. His thesis (Tentamen Inaugurale de Corporis Dolore) was written in a clear and lucid style.

The question now which involves the common origin of races is exciting much keen discussion in the scientific world, and Morton threw much light on the subject.

The original diversity of races is only admitted by a few. Morton began his study of anthropology in 1828. His method of comparing crania (*by the norma verticalis*), and his distribution of races, were then both undisputed. In the year 1827, he published an "Analysis of Tabular Spar." About the same time he was also much employed in studying palæontology, and he published a volume on this subject, entitled "Synopsis of the Organic Remains of the Cretaceous Group of the United States," illustrated with nineteen admirable plates. In 1831 he read a paper to the American Academy of Sciences on "Some Parasitic Worms;" another in 1841, on "An Albino Racoon;" and a third in 1844, on a "Supposed New Species of Hippopotamus." His *Crania Americana*, a very able work, he published in 1839. He published his renowned work the *Crania Ægyptiaca*, well known to all writers on ethnology, in 1844. In the same year he published a paper entitled, "An Inquiry into the distinctive characteristics of the Aboriginal Race of America." Before his death he was actively engaged in the study of Archæology—Egyptian, Assyrian, and American. He devoted much time to the subject of hybridity.

Amid these absorbing topics of research, he did not overlook his professional pursuits. He was largely engaged in practice, and was one of the leading practitioners of his day. He was the first to introduce into the United States the physical means of diagnosis in thoracic affections. He edited Mackintosh's "Practice of Physic," with Notes. In 1849 he published "An Illustrated System of Human Anatomy, Special, General, and Microscopic." He filled the chair of anatomy in the medical department of Pennsylvania College from 1839 to 1843.

From the time he commenced the study of anthropology to the period of his death, he increased his collection of skulls. At this moment it is the most complete collection of crania extant. At the time of Dr Morton's death, it consisted of 918 human crania. The collection also contains crania of mammals, birds, reptiles, and fishes; in all 1656 skulls. The collection was purchased by citizens of Philadelphia, and they presented it to the Academy.

His commentary on Humboldt's word *desolante*, shows that he had much sound philosophy and plain common sense.

"Humboldt's word *desolante* is true in sentiment and in morals; but, as you observe, it is wholly inapplicable to the physical reality. Nothing so humbles, so crushes my spirit, as to look into a mad-house, and behold the drivelling brutal idiocy so conspicuous in such places; it conveys a terrific idea of the disparity of human intelligences. But there is the unyielding, insuperable reality. It is *desolante* indeed to think, to *know*, that many of these poor mortals were born, were created so! But it appears to me to make little difference in the *sentiment* of the question whether they came into the world without their wits, or whether they lost them afterwards. And so, I would add, it makes little difference whether the mental inferiority of the Negro, the Samoiyede, or the Indian, is natural or acquired; for, if they ever possessed equal intelligence with the Caucasian, they have lost it; and if they never had it, they had nothing to lose. One party would arraign Providence for creating them originally different; another for placing them in circumstances by which they inevitably became so. Let us search out the truth, and reconcile it afterwards."

After five days' illness, he went peacefully and calmly to his eternal rest.

We add with much pleasure a letter received by the distinguished Dr Monro from Dr Morton.

PHILADELPHIA, May 26th.

MY DEAR SIR,—Your kind letter of September 16, and the two interesting volumes, were duly received, and should have been long ago acknowledged, had I not been looking for an opportunity to send you a memoir of my own in return, which pleasure I now have. The *Crania Ægyptiaca*, having been originally published in the Transactions of the American Philosophical Society, is restricted within narrower limits than I would have desired, but I am now preparing a second and more extended edition.

I have read with great interest and instruction your work on the Brain, and the internal capacity of the cranium, although I believe there is but one copy in this city, and that is in our Hospital Library.

If you possess a duplicate copy of it, I should esteem it a great favour to possess one, having failed in every attempt to procure the work.

I look back with pleasing recollections to my sojourn in Edinburgh, and the period of my graduation there in 1823. Since that time I have been engaged in professional duties in this city, but have found leisure to give some attention to natural science, and especially to geology and ethnology, which latter study is now my almost exclusive recreation.

I assure you that I feel much flattered by the kind sentiments expressed in your letter, and permit me to add that it will always give me peculiar pleasure to serve you on this side the Atlantic.

I will thank you to present my best respects to Dr W. P. Alison and Mr George Combe, both of whom I hold in grateful remembrance. I remain, dear Sir, very sincerely your obliged friend and servant,

SAMUEL GEORGE MORTON.

Indications of Weather, as shown by Animals, Insects, and Plants. By M. W. B. THOMAS of Cincinnati, Ohio.

The possibility of foretelling weather has occupied the attention of observers of natural facts from the earliest period of our records. The certainty with which anything is arrived at on this subject, like all other parts of natural science, depends upon the knowledge acquired of those things with which nature has most intimately connected it.

Without indulging in any comment, I will state a few particulars in regard to the different indicators with which nature has supplied us.

When a pair of migratory birds have arrived in the spring, they immediately prepare to build their nest, making a careful reconnoisance of the place, and observing the character of the season that is coming. If it be a windy one, they thatch the straw and leaves on the inside of the nest, between the twigs and the lining; and if it be very windy, they get pliant twigs and bind the nest firmly to the limb, securing all the small twigs with their saliva. If they fear the approach of a rainy season, they build their nests so as to be sheltered from the weather; but if a pleasant one, they build in the fair open place, without taking any of those extra precautions. In recording these facts, we have kept duly registered the name of the bird, the time of arrival in spring, the commencement of nesting, the materials of nest, and its position; the commencement of laying, number of eggs in each nest, commencement of incubation, appearances of young, departure in autumn.

But it is our insects and smaller animals which furnish us with the best means of determining the weather.

We will now take the Snails, and show the various phenomena they present. These animals do not drink, but imbibe moisture in their bodies during a rain. At regular periods after the rain, they exude this moisture from their bodies. We will take, for example, the *Helix alternata.* The first fluid exuded is the pure liquid. When this is exhausted, it then changes to light red, then deep red, then yellow, and, lastly, to a dark brown. The helix is very careful not to exude more of its moisture than is necessary. It might exude it all at once, but this is not in conformity to its general character, as this would prove too great an exertion. The *Helix alternata* is never seen abroad, except before a rain, when we find it ascending the bark of trees, and getting on the leaves. The *Helices arborea, indentata, ruderati*, and *minuta*, are also seen ascending the stems of plants two days before a rain. The *Helices clausa, ligera, Pennsylvanica*, and *elevata*, generally begin to crawl about two days before rain will descend. They are seen ascending the stems of plants. If it be a long and hard rain, they get on the sheltered side of the leaf; but, if it be a short one, they get on the outside of the leaf. The *luccinea* have also the same habits, differing only in colour of animals, as, before the rain, it is of a yellow colour, while after it is blue. The *Helices solitaria, zaleta, albolabris*, and *thyroideus*, not only show signs by means of exuding fluids, but by means of pores and protuberances. Before a rain, the bodies of *zaleta* and *H. thyroideus* have large tubercles rising from them.

These tubercles commence showing themselves ten days previous to the fall of rain they indicate; at the end of each of these tubercles is a pore. At the time of the fall of the rain, these tubercles, with their pores opened, are stretched to their utmost, to receive the water. Also, for a few days before a rain, a large and deep indentation appears in the *H. thyroideus*, beginning on the head, between the horns, and ending with the jointure at the shell. The *Helices solitaria* and *zaleta*, a few days before a rain, crawl to the most exposed hill side, where, if they arrive before the rain descends, they seek some crevice in the rocks, and then close the aperture of the shell with glutinous substance, which, when the rain approaches, they dissolve, and are then seen crawling about. In the *Helix albolabris*, the tubercles begin to rise after a rain, while before, they grew smaller, and, at the time of the rain, the body of the snail is filled with cavities to receive the moisture. The *H. zaleta, thyroideus*, and *albolabris*, move along at the rate of a mile in forty-four hours. They inhabit the most dense forests, and we regard it as a sure indication of a rain to observe them moving towards an exposed situation. The *Helices appressa, tridentata, falla*, and *paliata*, indicate the weather not only by exuding fluids, but by the colour of the animal. After a rain, the animal has a very dark appearance, but it grows of a bright colour as the water is expended, while just before the rain, it is of a yellowish-white colour. Also, just before a rain, striæ are observed to appear from the point of the head to the jointure of the shell. The superior *tentacula* are striated, and the sides are covered with tubercles. These helices move at the rate of a mile in fourteen days and sixteen hours. If they are observed ascending the cliff, it is a sure indication of a rain. They live in the cavities in the side of cliffs. The *Helix hirsuta* is of a black colour after a rain, but before, it is of a brown, tinged with blue around the edges of the animal. The *tentacula* are marked by cross striæ, and there is also to be seen, a few days before the rain, an indentation, which grows deeper as the rain approaches; this helix also exudes fluids, but not with the changes of colour of those before-mentioned.

We can also foretell a change of weather by the wasps and other insects.

The leaves of trees are even good barometers; most of them for a short, light rain, will turn up so as to receive their fill of water; but, for a long rain, they are doubled, so as to conduct the water away. The *Rana, Bufo*, and *Hyla*, are also sure indicators of rain; for, as they do not drink water, but absorb it into their bodies, they are sure to be found out at the time they expect rain.

The *Locusta* and *Gryllus* are also good indicators of a storm. A few hours before the rain, they are to be found under the leaves of trees, and in the hollow trunks. We have many times found them thus, but we have never known the instinct of these little fellows to lead them to unnecessary caution.

Experiments upon the formation of Minerals in the Humid way in Metalliferous Repositories. By M. de SANARMONT.

Geology has means of investigation which are peculiar to itself, and now comprehend a certain number of special truths definitely acquired to science. It is thus that geology has been able, without foreign aid, to characterize the manner of the formation of the sedimentary rocks, and to arrange them in series; it is thus that it has succeeded in distinguishing in crystalline rocks, and in metalliferous repositories, different classes, of which it can assign the probable origin; and in so far as it has not drawn conclusions too far removed from its fundamental principles, its anticipations have been almost always confirmed by experiment. It is to mineralogical chemistry that geology owes the useful experimental control of its rational conceptions. Crystalline minerals have, in fact, a complete chemical origin; and a more thorough study and knowledge of them must be advanced by chemical experiment. Chemistry, then, can do much for geology, by lending its means for experiment; but upon the condition of itself remaining purely geological, and of borrowing in its turn particular means of study, and the general data which the science, *a priori*, has collected upon all the conditional peculiarities of structure, relative position, association, or mutual exclusion, to which certain mineral species must needs be subject. In a word, it is necessary that all the circumstances where the natural position has left characteristic traces, discovered by the geologist, should reappear in the artificial operation of the chemist.

The experiments, then, of mineralogical synthesis should embrace the different groups of mineral species which are united in nature, and should support themselves upon certain probable geological inductions concerning the formation of the beds which they inclose. Certain isolated species have already been obtained, and principally those which approximate to the usual products according to the dry method. I have attempted to do more, and to discover some indices of the general causes which have originated the different classes of metalliferous beds. I commence this problem by the study of the concretionary veins which approach most nearly to the existing formations, and the principles I have just explained have been the starting point of the researches I am about to submit to the academy (French Academy.)

The concretionary repositories seemed to be formed by solution; the mineral species we there find would then be the products of the humid method, derived from liquid deposits, and to a certain extent may be compared to geysers and thermal springs. Moreover, the principles most generally prevalent, even at the present day, in these springs, are the carbonic and hydro-sulphuric acids, the alkaline salts, and amongst others the carbonates and the sulphates; these, then, are the reagents I propose first to employ. But amongst the different influences which may modify in the subterranean canals the usual chemical reactions, we must undoubtedly reckon first pressure, and a temperature increasing indefinitely with the depth; and I have endeavoured to realize this double experimental condition. It is very evident that this creates numerous difficulties; and we must not be surprised if the crystalline state of the products thus formed is sometimes imperfect, and always microscopic. Besides, it is not the size of the crystals which results from such problems, it is the mere fact of their creation; and in order to obtain more, all that is required is time, space, and rest, powerful means which belong to nature alone.

The method I have pursued essentially consists in producing all the chemical reactions in *a liquid condition*, and in glass tubes, hermetically sealed, heated from 100° to 350° C. I have almost solely employed solutions of carbonic and hydro-sulphuric gases, of bicarbonates and alkaline sulphurs, alone or mixed in variable proportions; I have then, I repeat, as a starting point, the composition of mineral waters and their most energetic principles. By these means of procedure, I have artificially formed a great number of natural compounds. Each family of minerals generally group themselves around a common generating agent; so that we might then classify them thus in relation to the presumed composition of the thermal depositions which have served to produce them. I do not wish to make this approximation too absolutely, as it appears to me to go beyond the immediate interpretation of the facts; and I shall limit myself here to the mention of the compounds which I have obtained, and the different classes of minerals to which they belong.

Native Metals.—Copper and silver, mixed, but not combined, as observed in certain mineral repositories in North America. Native arsenic.

Oxides.—Red iron ore, $Fe_2\,O_3$; quartz, $Si\,O_3$, in regular six-sided prisms, acuminated with six planes, with striæ, and sometimes with unequally-developed acuminating planes, so frequent in natural crystals. Red copper ore, or red oxide of copper, in red shining translucent octahedrons.

Carbonates.—Carbonates of magnesia, of iron, manganese, of cobalt, of nickel, of zinc, of copper, or malachite.

Sulphates.—Sulphate of baryta, in the primitive form.

Sulphurates.—Realgar, in transparent crystals, with the colours, lustre, and form, as in mineral veins. Sulphuret of antimony, in circular shining metallic-looking crystals. Sulphuret of bismuth, with similar characters as the preceding. Sulphurets of iron, of manganese, of cobalt, of nickel, of zinc, of copper. These last mentioned are massive, as is the case with those prepared in our laboratories; but it appears that the hydro-sulphuric acid, under certain conditions of temperature and pressure, is a solvent of sulphurets, and a general agent of crystallization. The properties of this acid explain the accumulation of metallic sulphurets in the deep parts of mineral repositories, and of metallic carbonates near their crop or out-goings. Arsenio-sulphurets, and antimonio-sulphurets were also formed.

Conclusions.—I had proposed to establish, upon experimental proofs, the controverted, and, as I think, very probable opinion, which attributes the filling up of the concretionary veins to incrusting thermal depositions, and to show that the formation of a great number of minerals which we there meet, whether they be crystallized or amorphous, do not always presuppose conditions or agents far removed from the actual *existing* causes. We thus, in fact, perceive that the two principal elements of the most extended thermal springs, the sulphurets and the alkaline bicarbonates, have sufficed to produce twenty-nine distinct mineral species, almost all crystallized, belonging to all the great families of the chemical compounds peculiar to concretionary beds, each of which has some representatives in my experiments. Means of synthesis equally simple, applicable however to compounds as variable, give certainly a great probability to the speculative ideas which have directed me in these researches. It will, moreover, be necessary to diversify them to a much greater extent, and we shall, in the same manner, have studied the different chemical agents, and the influences of every kind which can modify their effects; we shall undoubtedly succeed in defining the probable condition of the formation peculiar to each class of metalliferous beds, and by tracing their origin, step by step, in the same order of systematic experiments, we may finally arrive at the crystallized rocks which associate themselves to these beds by methods and phenomena of continuity which it is impossible to mistake.

On the Natural Provinces of the Animal World, and their Relation to the different Types of Man. By LOUIS AGASSIZ.*

There is one feature in the physical history of mankind which has been entirely neglected by those who have studied this subject, viz., the natural relations between the different types of man, and the animals and plants inhabiting the same regions. The sketch here presented is intended to supply this deficiency, as far as it is possible in a mere outline delineation, and to show *that the boundaries within which the different natural combinations of animals are known to be circumscribed upon the surface of our earth, coincide with the natural range of distinct types of man.* Such natural combinations of animals, circumscribed within definite boundaries, are called *faunæ*, whatever be their home—land, sea, or river. Among the animals which compose the fauna of a country, we find types belonging exclusively there, and not occurring elsewhere; such are, for example, the ornithorynchus of New Holland, the sloths of

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* Dr Usher, Dr Nott, and G. R. Gliddon, on the Types of Mankind.

America, the hippopotamus of Africa, and the walruses of the Arctics; others which have only a small number of representatives beyond the fauna which they specially characterize, as, for instance, the marsupials of New Holland, of which America has a few species, such as the opossum; and again, others which have a wider range, such as the bears, of which there are distinct species in Europe, Asia, or America, or the mice and bats which are to be found all over the world, except in the Arctics. That fauna will, therefore, be most easily characterized, which possesses the largest number of distinct types proper to itself, and of which the other animals have little analogy with those of neighbouring regions, as, for example, the fauna of New Holland.

The inhabitants of fresh waters furnish also excellent characters for the circumscription of faunæ. The fishes, and other fluviatile animals, from the larger hydrographic basins, differ no less from each other than the mammalia, the birds, the reptiles, and the insects of the countries which these rivers water. Nevertheless, some authors have attempted to separate the fresh water animals from those of the land and sea, and to establish distinct divisions for them, under the name of fluviatile faunæ. But the inhabitants of the rivers and lakes are too intimately connected with those of their shores to allow of a rigorous distinction of this kind. Rivers never establish a separation between terrestrial faunæ. For the same reason, the faunæ of the inland seas cannot be completely isolated from the terrestrial ones; and we shall see hereafter that the animals of southern Europe are not bound by the Mediterranean, but are found on the southern shore of that sea, as far as the Atlas. We shall, therefore, distinguish our zoological regions according to the combination of species which they inclose, rather than according to the element in which we find them.

If the grand divisions of the animal kingdom are primordial and independent of climate, this is not the case with regard to the ultimate local circumscription of species; these are, on the contrary, intimately connected with the conditions of temperature, soil, and vegetation. A remarkable instance of this distribution of animals with reference to climate may be observed in the Arctic fauna, which contains a great number of species common to the three continents converging towards the North Pole, and which presents a striking uniformity, when compared with the diversity of the temperate and tropical faunæ of those same continents.

The Arctic fauna extends to the utmost limits of the cold and barren regions of the North. But from the moment that forests appear, and a more propitious soil permits a larger development of animal life and of vegetation, we see the fauna and flora not only diversified according to the continents on which they exist, but we observe also striking distinctions between different parts of the same *continent*; thus, in the Old World, the animals vary, not only from the polar circle to the equator, but also in the opposite direction. Those of the western coast of Europe are not the same as those of the basin of the Caspian Sea, or of the eastern coast of Asia, nor are those of the eastern coast of America the same as those of the western.

The first fauna, the limits of which we would determine with precision, is the Arctic. It offers the same aspects in three parts of the world, which converge towards the North Pole. The uniform distribution of the animals by which it is inhabited forms its most striking character, and gives rise to a sameness of general features which is not found in any other region. Though the air-breathing species are not numerous here, the large number of individuals compensates for this deficiency ; and among the marine animals we find an astonishing profusion and variety of forms.

In this respect the vegetable and animal kingdoms differ entirely from each other ; and the measure by which we estimate the former is quite false as applied to the latter. Plants become stunted in their growth, or disappear before the rigours of the climate; while, on the contrary, all classes of the animal kingdom have representatives, more or less numerous, in the Arctic fauna.

Neither can they be said to diminish in size under these influences ; for, if the Arctic representatives of certain classes, particularly the insects, are smaller than the analogous types in the tropics, we must not forget, on the other hand, that the whales and larger cetacea have here their most genial home, and make amends, by their more powerful structure, for the inferiority of other classes. Also, if the animals of the north are less striking in external ornament—if their colours are less brilliant—yet we cannot say that they are more uniform ; for, though their tints are not so bright, they are none the less varied in their distribution and arrangement.

The limits of the Arctic fauna are very easily traced. We must include therein all animals living beyond the line where forests cease, and inhabiting countries entirely barren. Those which feed upon flesh, seek fishes, hares, lemmings—a rodent the size of our rat. Those which live on vegetable substances are not numerous. Some gramineous plants, mosses, and lichens, serve as pasture to the ruminants and rodents ; while the seeds of a few flowering plants, and of the dwarf birches, afford nourishment to the little granivorous birds, such as linnets and buntings. The species belonging to the sea-shore feed upon marine animals, which live themselves upon each other, or upon marine plants.

The larger mammalia which inhabit this zone are—the white bear, the walrus, numerous species of seal, the reindeer, the musk ox, the narwal, the cachalot, and whales in abundance. Among the smaller species, we may mention the white fox, the polar hare, and the lemming. The birds are not less characteristic. Some marine eagles and wading birds, in smaller numbers, are found ;

but the aquatic birds of the family of palmipedes are those which especially prevail. The coasts of the continents and of the numerous islands in the Arctic seas are peopled by clouds of gannets, of cormorants, of penguins, of petrels, of ducks, of geese, of mergansers, and of gulls, some of which are as large as eagles, and, like them, live on prey. No reptile is known in this zone. Fishes are, however, very numerous, and the rivers especially swarm with a variety of species of the salmon family. A number of representatives of the inferior class of worms, of crustacea, of mollusks, of echinoderms, and of medusæ, are also found here.

Within the limits of this fauna we meet a peculiar race of men, known in America under the name of Esquimaux, and under the names of Laplanders, Samoyedes, and Tchuktshes, in the north of Asia. This race, so well known since the voyage of Captain Cook and the Arctic expeditions of England and Russia, differs alike from the Indians of North America, from the whites of Europe, and the Mongols of Asia, to whom they are adjacent. The uniformity of their characters along the whole range of the Arctic seas forms one of the most striking resemblances which these people exhibit to the fauna with which they are so closely connected.

The semi-annual alternation of day and night in the Arctic regions has a great influence upon their modes of living. They are entirely dependent upon animal food for their sustenance; no farinaceous grains, no nutritious tubercles, no juicy fruits, growing under those inhospitable latitudes. Their domesticated animals are, the reindeer in Asia and a peculiar variety of the dog, the Esquimaux dog in North America, where even the reindeer is not domesticated.

Though the Arctic fauna is essentially comprised in the Arctic circle, its organic limit does not correspond rigorously to this line, but rather to the isotherm of 32° Fahr., the outline of which presents numerous undulations. This limit is still more natural when it is made to correspond with that of the disappearance of forests. It then circumscribes those immense plains of the north which the Samoyedes call *tundras*, and the Anglo-Americans *barren lands*.

The naturalists who have overlooked this fauna, and connected it with those of the temperate zone, have introduced much confusion in the geographical distribution of animals, and have failed to recognize the remarkable coincidence existing between the extensive range of the Arctic race of men, and the uniformity of the animal world around the northern Pole.

The first column of the accompanying table represents the types which characterize best this fauna,—viz., the white or polar bear, the walrus, the seal of Greenland, the reindeer, the right whale, and the eider duck. The vegetation is represented by the so-called reindeer moss—a lichen which constitutes the chief food of the herbivorous animals of the Arctics and the high Alps during winter.

To the glacial zone, which incloses a single fauna, succeeds the temperate zone, included between the isotherms of 32° and 74° Fahr., characterized by its pine forests, its amentacea, its maples, its walnuts, and its fruit trees, and from the midst of which arise, like islands, lofty mountain chains or high table-lands, clothed with a vegetation which in many respects recals that of the glacial regions. The geographical distribution of animals in this zone forms several closely-connected but distinct combinations. It is the country of the terrestrial bear, of the wolf, the fox, the weasel, the marten, the otter, the lynx, the horse and the ass, the boar, and a great number of stags, deer, elk, goats, sheep, bulls, hares, squirrels, rats, &c., to which are added, southward, a few representatives of the tropical zone.

Whenever this zone is not modified by extensive and high table-lands and mountain chains, we may distinguish in it four *secondary* zones, approximating gradually to the character of the tropics, and presenting therefore a greater diversity in the types of its southern representatives than we find among those of its northern boundaries. We have, first, adjoining the Arctics, a *sub-Arctic* zone, with an almost uniform appearance in the Old as well as the New World, in which pine forests prevail, the home of the moose; next, a *cold temperate zone*, in which amentaceous trees are combined with pines, the home of the fur animals; next, a *warm temperate zone*, in which the pines recede, whilst to the prevailing amentaceous trees a variety of evergreens are added, the chief seat of the culture of our fruit trees, and of the wheat; and a *sub-tropical zone*, in which a number of tropical forms are combined with those characteristic of the warm temperate zone. Yet there is throughout the whole of the temperate zone one feature prevailing—the repetition, under corresponding latitudes, but under different longitudes, of the same genera and families, represented in each botanical or zoological province by distinct so-called *analogous or representative species*, with a very few subordinate types peculiar to each province; for it is not until we reach the tropical zone that we find distinct types prevailing in each fauna and flora. Again, owing to the inequalities of the surface, the secondary zones are more or less blended into one another; as, for instance, in the table-lands of Central Asia and western North America, where the whole temperate zone preserves the features of a cold temperate region; or the colder zones may appear like islands rising in the midst of the warmer ones, as the Pyrenees, the Alps, &c., the summits of which partake of the peculiarities of the Arctic and sub-Arctic zones, whilst the valleys at their base are characterized by the flora and the fauna of the cold or warm temperate zones. It may be proper to remark, in this connection, that the study of the laws regulating the geographical distribution of natural families of animals and plants upon the whole surface of our globe differs entirely from that of the association and combination of a variety of animals and plants within definite regions, forming peculiar fauna and flora.

Considering the whole range of the temperate zone from east to west, we may divide it, in accordance with the prevailing physical features, into—1*st*, An *Asiatic* realm, embracing Mantchuria, Japan, China, Mongolia, and passing through Turkestan—into, 2*d*, The *European* realm, which includes Iran as well as Asia Minor, Mesopotamia, Northern Arabia, and Barbary, as well as Europe, properly so called; the western parts of Asia, and the northern parts of Africa being intimately connected by their geological structure with the southern parts of Europe; and, 3*d*, The North American realm, which extends as far north as the table-land of Mexico.

With these qualifications we may proceed to consider the faunæ which characterize these three realms. But, before studying the organic characters of this zone, let us glance at its physical constitution. The most marked character of the temperate zone is found in the inequality of the four seasons, which give to the earth a peculiar aspect in different epochs of the year, and in the gradual, though more or less rapid, passage of these seasons into each other. The vegetation particularly undergoes marked modifications; completely arrested, or merely suspended, for a longer or shorter time, according to the proximity of the arctic or the tropical zone. We find it by turns in a prolonged lethargy, or in a state of energetic and sustained development. But in this respect there is a decided contrast between the cold and warm portions of the temperate zone. Though they are both characterized by the predominance of the same families of plants, and in particular by the presence of numerous species of the coniferous and amentaceous plants, yet the periodical sleep which deprives the middle latitudes of their verdure is more complete in the colder regions than in the warmer, which is already enriched by some southern forms of vegetation, and where a part of the trees remain green all the year. The succession of the seasons produces, moreover, such considerable changes in the climatic conditions in this zone, that all the animals belonging to it cannot sustain them equally well. Hence a large number of them migrate at different seasons from one extremity of the zone to the other, especially certain families of birds. It is known to all the world that the birds of Northern Europe and America leave their ungenial climate in the winter, seeking warmer regions as far as the Gulf of Mexico and the Mediterranean; the shores of which, even those of the African coasts, make a part of the temperate zone. Analogous migrations take place also in the north of Asia. Such migrations are not, however, limited to the temperate zone; a number of species from the arctic regions go for the winter into the temperate zone, and the limits of their migrations may aid us in tracing the natural limits of the faunæ, which thus link themselves to each other, as the human races are connected by civilization.

The temperate zone is not characterized, like the arctic, by one and the same fauna; it does not form, as the arctic does, one continuous zoological zone around the globe. Not only do the animals change from one hemisphere to another, but these differences exist even between various regions of the same hemisphere. The species belonging to the western countries of the old world are not identical with those of the eastern countries. It is true that they often resemble each other so closely, that until very recently they have been confounded. It has been reserved, however, for modern zoology and botany to detect those nice distinctions. For instance, the coniferæ of the Old World, even within the subarctic zone, are not identical with those of America. Instead of the Norway and black pine, we have here the balsam and the white spruce; instead of the common fir, the *Pinus rigida;* instead of the European larch, the hacmatac, &c.; and further south the differences are still more striking. In the temperate zone proper, the oaks, the beeches, the birches, the hornbeams, the hop hornbeams, the chestnuts, the buttonwoods, the elms, the linden, the maples, and the walnuts, are represented in each continent by peculiar species differing more or less. Peculiar forms make here and there their appearance, such as the gum trees, the tulip trees, the magnolias. The evergreens are still more diversified. We need only mention the camellias of Japan, and the kalmias of America, as examples. Among the tropical forms extending into the warm temperate zone, we notice particularly the palmetto in the southern United States, and the dwarf chamærops of Southern Europe. The animal kingdom presents the same features. In Europe we have, for instance, the brown bear, in North America the black bear, in Asia the bear of Thibet; the European stag and the European deer are represented in North America by the Canadian stag or wapiti and the American deer; and in Eastern Asia by the musk deer. Instead of the mouflon, North America has the rocky mountain sheep, and Asia the argali. The North American buffalo is represented in Europe by the wild auerochs of Lithuania, and in Mongolia by the yak; the wild cats, the martens, and weasels, the wolves and foxes, the squirrels and mice (excepting the imported house mouse), the birds, the reptiles, the fishes, the insects, the mollusks, &c., though more or less closely allied, are equally distinct specifically. The types peculiar to the Old or the New World are few. Among them may be mentioned the horse and ass, and the dromedary of Asia, and the opossum of North America. We would add, that in the present state of our knowledge we recognise the following combinations of animals within the limits of the temperate zone, which may be considered as so many distinct zoological provinces or faunæ.

In the *Asiatic realm,*—1st, a north-eastern fauna, the *Japanese fauna;* 2d, a south-eastern fauna, the *Chinese fauna*, and a central fauna, the *Mongolian fauna*, followed westward by the Caspian *fauna*, which partakes partly of the Asiatic and partly of the European zoological character; its most remarkable animal, antelope saiga, ranging west as far as Southern Russia. The Japanese and Chinese faunæ stand to each other in the same relation as Southern Europe and Northern Africa, and it remains to be ascertained by further investigations whether the *Japanese fauna proper*, and a more western continental fauna, which might be called the *Mandshurian or Tongusian* fauna. But since it is not my object to describe separately all faunæ, but chiefly to call attention to the coincidence existing between the natural limitation of the races of man, and the geographical range of the zoological provinces, I shall limit myself here to some general remarks respecting the Mongolian fauna, in order to show that the Asiatic zoological realm differs essentially from the European and the American. The most remarkable animals of this fauna are the bear of Thibet (*Ursus thibetanus*), the musk deer (*Moschus moschiferus*), the tzeiran (*Antelope gutturosa*), the Mongolian goat (*Capra siberica*), the argali (*Ovis argali*), and the yak (*Bos grunniens*). This is also the home of the Bactrian or double-hunched camel, and of the wild horse (*Equus caballus*), the wild ass (*Equus onager*), and the dtschigetai (*Equus hemionus*). The wide distribution of the musk-deer in the Altai and the Himalayan and Chinese Alps, shows the whole Asiatic range of the temperate zone to be a most natural zoological realm, subdivided into distinct provinces by the greater localization of the largest number of its representatives.

If we now ask what are the nations of men inhabiting those regions, we find that they all belong to the so-called Mongolian race, the natural limits of which correspond exactly to the range of the Japanese, Chinese, Mongolian, and Caspian faunæ taken together, and that peculiar types, distinct nations of this race, cover respectively the different faunæ of this realm ;—the Japanese inhabiting the Japanese zoological province, the Chinese the Chinese province, the Mongols the Mongolian province, and the Turks the Caspian province; eliminating, of course, the modern establishment of Turks in Asia Minor and Europe.

The unity of Europe (exclusive of its arctic regions), in connection with South-western Asia and Northern Africa, as a distinct zoological realm, is established by the range of its mammalia and by the limits of the migrations of its birds, as well as by the physical features of its whole extent. Thus we find its deer and stag, its hare, its squirrel, its wolf and wild cat, its fox and jackal, its otter, its weasel and marten, its badger, its bear, its mole, its hedgehogs, and a number of bats, either extending over the whole realm in Europe, Western Asia, and Northern Africa, or so linked together as to show that in their combination with the birds, reptiles, fishes, &c., of the same countries, they constitute a natural zoological association analogous to that of Asia, but essentially different in reference to species. Like the eastern realm, this European world may be subdivided into a number of distinct faunæ, characterized each by a variety of peculiar animals. In Western Asia we find, for instance, the common camel, instead of the Bactrian; while Mount Sinai, Mounts Taurus and Caucasus, have goats and wild sheep which differ as much from those of Asia as they differ from those of Greece, of Italy, of the Alps, of the Pyrenees, of the Atlas, and of Egypt. Wild horses are known to have inhabited Spain and Germany; and a wild bull extended over the whole range of Central Europe, which no longer exists there. The Asiatic origin of our domesticated animals may, therefore, well be questioned, even if we were still to refer Western Asia to the Asiatic realm; since the ass, and some of the breeds of our horse, only belong to the table-lands of Iran and Mongolia, whilst the other species, including the cat, may all be traced to species of the European realm. The domesticated cat is referred by Rüppell to *Felis maniculata* of Egypt; by others, to *Felis catus-ferus* of Central Europe; thus, in both cases, to an animal of the European realm. Whether the dog be a species by itself, or its varieties derived from several species which have completely amalgamated, or be descended from the wolf, the fox, or the jackal, every theory must limit its natural range to the European world. The Merino sheep is still represented in the wild state by the mouflon of Sardinia, and was formerly wild in all the mountains of Spain; whether the sheep of the patriarchs was derived from those of Mount Taurus or from Armenia, still they differed from those of Western Europe; since, a thousand years before our era, the Phœnicians preferred the wool from the Iberian peninsula to that of their Syrian neighbours. The goats differ so much in different parts of the world, that it is still less possible to refer them to one common stock; and while Nepaul and Cashmere have their own breeds, we may well consider those of Egypt and Sinai as distinct, especially as they differ equally from those of Caucasus and of Europe. The common bull is derived from the wild species which has become extinct in Europe, and is not identical with any of the wild species of Asia, notwithstanding some assertions to the contrary. The hog descends from the common boar, now found wild over the whole temperate zone in the Old World. Both ducks and geese have their wild representatives in Europe; so also the pigeon. As for the common fowls, they are decidedly of east Asiatic origin; but the period of their importation is not well known, nor even the wild species from which they are derived. The wild turkey is well known as an inhabitant of the American continent.

Now, taking further into account the special distribution of all the animals, wild as well as domesticated, of the European temperate zone, we may subdivide it into the following eight faunæ:—1. *Scandinavian fauna;* 2. *Russian fauna;* 3. *The fauna of Central Europe*; 4. *The fauna of Southern Europe;* 5. *The fauna* *of Iran; 6. The Syrian fauna; 7. The Egyptian fauna; and 8. The fauna of the Atlas.* The special works upon the zoology of Europe, the great works illustrative of the French expeditions in Egypt, Morocco, and Algiers, the travels of Rüpell and Russeger in Egypt and Syria, of M. Wagner in Algiers, of Demidoff in Southern Russia, &c. &c., and the special treatises on the geographical distribution of mammalia by A. Wagner, and of animals in general by Schmarda, may furnish more details upon the zoology of these countries.

Here, again, it cannot escape the attention of the careful observer, that the European zoological realm is circumscribed within exactly the same limits as the so-called white race of man, including as it does, the inhabitants of South-western Asia, and of North Africa, with the lower parts of the valley of the Nile. We exclude, of course, modern migrations and historical changes of habitation from this assertion. Our statements are to be understood as referring only to the aboriginal or ante-historical distribution of man, or rather to the distribution as history finds it; and in this respect there is a singular fact, which historians seem not to have sufficiently appreciated, that the earliest migrations recorded in any form, show us man meeting man wherever he moves upon the habitable surface of the globe, small islands excepted.

It is, farther, very striking, that the different subdivisions of this race, even to the limits of distinct nationalities, cover precisely the same ground as the special faunæ or zoological provinces of this most important part of the world, which in all ages has been the seat of the most advanced civilization. In the south-west of Asia we find (along the table-land of Iran) Persia and Asia Minor; in the plains southward, Mesopotamia and Syria; along the sea-shores, Palestine and Phœnicia; in the valley of the Nile, Egypt; and along the northern shores of Africa, Barbary. Thus we have Semitic nations covering the north African and south-west Asiatic faunæ, while the south European peninsulas, including Asia Minor, are inhabited by Græco-Roman nations, and the cold, temperate zone, by Celto-Germanic nations; the eastern range of Europe being peopled by Sclaves. This coincidence may justify the inference of an independent origin for these different tribes, as soon as it can be admitted that the races of men were primitively created in nations; the more so, since all of them claim to have been *autochthones* of the countries they inhabit. This claim is so universal that it well deserves more attention. It may be more deeply founded than historians generally seem inclined to grant. The columns of our table exhibit the animals characteristic of the temperate part of the European zoological realm, and show their close resemblance to those of the corresponding Asiatic fauna; the species being representative species of the same genera, with the exception of the musk deer, which has no analogues in Europe. Though temperate America resembles closely, in its animal creation, the countries of Europe and Asia belonging to the same zone, we meet with physical and organic features in this continent which differ entirely from those of the Old World. The tropical realms connected there with those of the temperate zone, though bound together by some analogies, differ essentially from one another. Tropical Africa has hardly any species in common with Europe, though we may remember that the lion once extended to Greece, and that the jackal is to this day found upon some islands in the Adriatic and in Morea. Tropical Asia differs equally from its temperate regions, and Australia forms a world by itself. Not so in Southern America. The range of mountains which extend, in almost unbroken continuity, from the Arctic to Cape Horn, establishes a similarity between North and South America, which may be traced also, to a great degree, in its plants and animals. Entire families which are peculiar to this continent have their representatives in North as well as South America, the cactus and didelphis, for instance; some species, as the puma, or American lion, may even be traced from Canada to Patagonia. In connection with these facts, we find that tropical America, though it has its peculiar types, as characteristic as those of tropical Africa, Asia, and Australia, does not furnish analogues of the giants of Africa and Asia; its largest pachyderms being tapirs and peccaries, not elephants, rhinoceroses, and hippopotami; and its largest ruminants, the llamas and alpacas, and not camels and giraffes; whilst it reminds us in many respects of Australia, with which it has the type of marsupials in common, though ruminants and pachyderms, and even monkeys, are entirely wanting there. Thus, with due qualification, it may be said that the whole continent of America, when compared with the corresponding twin continents of Europe—Africa or Asia—Australia is characterized by a much greater uniformity of its natural productions, combined with a special localization of many of its subordinate types, which will justify the establishment of many special faunæ within its boundaries.

With these facts before us, we may expect that there should be no great diversity among the tribes of man inhabiting this continent; and, indeed, the most extensive investigation of their peculiarities has led Dr Morton to consider them as constituting but a single race, from the confines of the Esquimaux down to the southernmost extremity of the continent. But at the same time it should be remembered that, in accordance with the zoological character of the whole realm, this race is divided into an infinite number of small tribes, presenting more or less difference one from another.

As to the special faunæ of the American continent, we may distinguish, within the temperate zone, a *Canadian fauna*, extending from Newfoundland across the great lakes to the base of the rocky mountains, a fauna of the *North American table-land*, a fauna of the north-west coast, a fauna of the *middle* United States, a fauna of the southern United States, and a *Californian fauna*, the characteristic features of which I shall describe on another occasion.

When we consider, however, the isolation of the American continent from those of the Old World, nothing is more striking in the geographical distribution of animals, than the exact correspondence of all the animals of the northern temperate zone of America with those of Europe; all the characteristic forms of which, as may be seen by the fourth column of our table, belong to the same genera, with the exception of a few subordinate types, not represented among our figures—such as the opossum and the skunk.

In tropical America we may distinguish *a Central American fauna, a Brazilian fauna, a fauna of the Pampas, a fauna of the Cordilleras, a Peruvian fauna, and a Patagonian fauna ;* but it is unnecessary for our purpose to mention here their characteristic features, which may be gathered from the works of Prince New Wied, of Spix and Martius, of Tschudi, of Pöppig, of Ramon de la Sagra, of Darwin, &c.

The slight differences existing between the faunæ of the temperate zone have required a fuller illustration than may be necessary to characterize the zoological realms of the tropical regions, and the southern hemisphere generally. It is sufficient for our purpose to say here, that these realms are at once distinguished by the prevalence of peculiar types, circumscribed within the natural limits of the three continents, extending in complete isolation towards the southern pole. In this respect there is already a striking contrast between the northern and the southern hemisphere. But the more closely we compare them with one another, the greater appear their differences. We have already seen how South America differs from Africa, the East Indies, and Australia, by its closer connection with North America. Notwithstanding, however, the absence in South America of those sightly animals so prominent in Africa and tropical Asia, its general character is, like that of all the tropical continents, to nourish a variety of types which have no close relations to those of other continents. Its monkeys and edentata belong to genera which have no representatives in the Old World. Among pachyderms, it has peccaries, which are entirely wanting elsewhere ; and though the tapirs occur also in the Sunda Islands, that type is wanting in Africa, where, in compensation, we find the hippopotamus, not found in either Asia or America. We have already seen that the marsupials of South America differ entirely from those of Australia. Its ostriches differ also generally from those of Africa, tropical Asia, New Holland, &c.

If we compare, further, the southern continents of the Old World with one another, we find a certain uniformity between the animals of Africa and tropical Asia. They have both elephants and rhinoceroses, though each has its peculiar species of these genera, which occur neither in America nor in Australia; whilst cercopitheci and antelopes prevail in Africa, and long-armed monkeys and stags in tropical Asia. Moreover, the black orangs are peculiar to Africa, and the red orangs to Asia. As to Australia, it has neither monkeys nor pachyderms, nor edentata, but only marsupials and monotremes. We need therefore not carry these comparisons further to be satisfied that Africa, tropical Asia, and Australia, constitute independent zoological realms.

The continent of Africa, south of the Atlas, has a very uniform zoological character. This realm may, however, be subdivided, according to its local peculiarities, into a number of distinct faunæ. In its more northern parts, we distinguish the fauna of the Sahara and those of Nubia and Abyssinia, the latter of which extends over the Red Sea into the tropical parts of Arabia. These faunæ have been particularly studied by Rüppell and Ehrenberg, in whose works more may be found respecting the zoology of these regions. They are inhabited by two distinct races of men, the Nubians and Abyssinians, receding greatly in their features from the woolly-haired negroes with flat, broad noses, which cover the more central parts of the continent. But even here we may distinguish the fauna of Senegal from that of Guinea and that of the African table-land. In the first, we notice particularly the chimpanzee; in the second, the gorilla; there is no anthropoid monkey in the third.

The tabular view gives figures of the most prominent animals of the genuine West African type. A fuller illustration of this subject might show how peculiar tribes of negroes cover the limits of the different faunæ of tropical Africa, and establish in this respect a parallelism between the nations of this continent and those of Europe. We are chiefly indebted to French naturalists for a better knowledge of the natural history of this part of the world. In tabular view, we have represented the animals of our Capelands, in order to show how the African fauna is modified upon the southern extremity of this continent, which is inhabited by a distinct race of men, the Hottentots. The zoology of South Africa may be studied in the works of Lichtenstein and Andrew Smith.

The East Indian realm is very well known zoologically—thanks to the efforts of English and Dutch naturalists—and may be subdivided into three faunæ,—that of Dukhun, that of the Indo-Chinese peninsula, and that of the Sunda Islands, Borneo, and the Philippines. Its characteristic animals, represented in the tabular view, may be readily contrasted with those of Africa. There is, however, one feature in this realm which requires particular attention, and has a high importance with reference to the study of the races of men. We find here upon Borneo (an island not so extensive as Spain) one of the best known of those anthropoid monkeys, the orang-outang; and with him, as well as upon the adjacent islands of Java and Sumatra, and along the coasts of the two East

Indian peninsulæ, not less than ten other different species of hylobates, the long-armed monkeys—a genus which, next to the orang and chimpanzee, ranks nearest to man. One of these species is circumscribed within the island of Java, two along the coast of Coromandel, three upon that of Malacca, and four upon Borneo. Also, eleven of the highest organized beings which have performed their part in the plan of creation within tracts of land inferior in extent to the range of any of the historical nations of men. In accordance with this fact, we find three distinct races within the boundaries of the East Indian realm: the Telingan race in anterior India, the Malays in posterior India, and upon the Islands, upon which the Negrillos occur with them. Such combinations notify fully a comparison of the geographical range covered by distinct European nations, with the narrow limits occupied upon earth by the orangs, the chimpanzees, and the gorillas; and though I still hesitate to assign to each an independent origin (perhaps rather from the difficulty of divesting myself of the opinions universally received, than from any intrinsic evidence), I must, in presence of these facts, insist at least upon the probability of such an independence of origin of all nations; or, at least, of the independent origin of a primitive stock for each, with which at some future period migrating or conquering tribes more or less completely amalgamated, as in the case of mixed nationalities. The evidence adduced from the affinities of the languages of different nations in favour of a community of origin is of no value, when we know that among vociferous animals every species has its peculiar intonations, and that the different species of the same family produce none as closely allied, and forming as natural combinations, as the so-called Indo-Germanic languages compared with one another. Nobody, for instance, would suppose that because the notes of the different species of thrushes, inhabiting different parts of the world, bear the closest affinity to one another, these birds must all have a common origin; and yet, with reference to man, philologists still look upon the affinities of languages as affording direct evidence of such a community of origin, among the races, even though they have already discovered the most essential differences in the very structure of these languages.

Ever since New Holland was discovered, it has been known as the land of zoological marvels. All the animals differ so completely from those of other parts of our globe, that it may be said to constitute a world in itself, as isolated in that respect from the other continents, as it truly is in its physical relations. As a zoological realm, it extends to New Guinea and some adjacent islands. New Holland, however, constitutes a distinct fauna, which at some future time may be still farther subdivided, differing from that of the islands north of it. The characteristic animals of this insular continent are represented in the tabular view. They all belong to two families only, considering the class of mammalia alone, the marsupials and the monotremes. Besides these are found bats and mice, and a wild dog; but there are neither true edentata nor ruminants, nor pachyderms nor monkeys, in this realm, which is inhabited by two races of men, the Australian in New Holland, and the Papuans upon the islands. The isolation of the zoological types of Australia, inhabiting as they do a continent partaking of nearly all the physical features of the other parts of the world, is one of the most striking evidences that the presence of animals upon earth is not determined by physical conditions, but established by the direct agency of a Creator.

Of Polynesia, its races and animals, it would be difficult to give an idea in such a condensed picture as this. I pass them, therefore, entirely unnoticed.

Tabular view of the Natural Provinces of the Animal World and their relation to the different Types of Man.

I.—*Arctic Realm.*

1. Head of Esquimaux
2. White Bear (Ursus maritimus)
3. Walrus (Trichecus rosmarus)
4. Reindeer (Cervus tarandus)
5. Harp Seal (Phoca grænlandica)
6. Right Whale (Balæna mysticetus)
7. Eider Duck (Anas mollissima)
8. Reindeer Moss (Cladonia rangiferina)

II.—*Mongol Realm.*

9. Head of Chinese
10. Bear (Ursus thibetanus)
11. Musk Deer (Moschus moschiferus)
12. Antelope (Antelope gutturosa)
13. Goat (Capra siberica)
14. Sheep (Ovis argali)
15. Yak (Bos grunniens)

III.—*European Realm.*

16. Head of European
17. Bear (Ursus arctos)
18. Stag (Cervus elaphas)
19. Antelope (Antelope rupicarpa)
20. Goat (Capra Ibex)
21. Sheep (Ovis musimon)
22. Auerochs (Bos urus)

IV.—*American Realm.*

23. Head of Indian chief
24. Bear (Ursus americanus)
25. Stag (Cervus virginianus)
26. Antelope (Ant. frucifera)
27. Goat (Capra americana)
28. Sheep (Ovis montana)
29. Bison (Bos americanus)

V.—*African Realm.*

30. Head of Creole Negro
31. Chimpanzee (Troglodytes niger)
32. Elephant (Elephas africanus)
33. Rhinoceros (R. bicornis)
34. Hippopotamus (H. amphibius)
35. Wart Hog (Phacochærus æliani)
36. Giraffe (Cameleopardalis giraffa)

VI.—*Hottentot Fauna.*

Head of Bushman
Hyena Genet (Proteles Lalandii)
Quagga (Equus quagga)
Rhinoceros (R. simus)

Cape Hyrax (Hyrax capensis)
Ant-eater (Orycteropus capensis)
Cape Ox (Bos Cafre)

Malayan Realm.

Head of Malay
Orang-utan (Pithecus satyrus)
Elephant (Elephas indicus)
Rhinoceros (R. sondaicus)
Tapir (Tapirus malayanus)
Stag (Cervus Muntjac)
Ox (Bos arnee)

Australian Realm.

Head of Alfouroux
Spotted Opossum (Dasyurus viverra)
Ant-eater (Myrmecobius fasciatus)
Rabbit (Parameles lagotis)
Phalanger (Phalangista vulpina)
Wombat (Phascolarctos cinereus)
Squirrel (Petaurus saureus)
Kangaroo (Macropus giganteus)
Duckbile (Ornithorynchus paradoxus)

Tabular View of the Faunas.

I.—Arctic Realm, inhabited by Hyperboræns, and containing an *Hyperborean* fauna.
II.—Asiatic Realm, inhabited by Mongols, and sub-divided into
    Mandchurian fauna } in the temperate range of the zone.
    Japanese fauna }
    Chinese fauna, in the warmer part.
    Central Mongolian fauna.
    Caspian (western) fauna.
III.—European Realm, inhabited by White Men, and divided into
    Scandinavian fauna.
    Russian fauna.
    Central European fauna.
    South European fauna.
    North African fauna.
    Egyptian fauna.
    Syrian and an Iranian fauna.
IV.—American Realm, inhabited by American Indians; North America divided into
    Canadian fauna.
    Alleghanian fauna, or fauna of the Middle States.
    Louisianian fauna, or fauna of the Southern States.
    Table-land fauna, or fauna of the Rocky Mountains.
    North-west Coast fauna.
    Californian fauna.
  Central America, subdivided into
    Mainland fauna.
    Antilles fauna.
  South America, divided into
    Brazilian fauna.
    Pampas fauna.
    Cordilleras fauna.
    Peruvian fauna.
    Patagonian fauna.

V.—African Realm, inhabited by Nubians, Abyssinians, Foolahs, Negroes, Hottentots, Bosjesmans, and divided into
- *Saharian* fauna.
- *Nubian* fauna.
- *Abyssinian* fauna, (extending to Arabia).
- *Senegambian* fauna.
- *Guinean* fauna.
- *African Table-land* fauna.
- *Cape of Good Hope* fauna.
- *Madagascar* fauna.

VI.—East Indian (or Malayan) Realm, inhabited by Telingans, Malays, Negrillos, and divided into
- *Dunkhan* fauna.
- *Indo-Chinese* fauna.
- *Sunda Islandic* fauna, (including Borneo and the Philippines).

VII.—Australian Realm, inhabited by Papuans, Australians, and divided into
- *Papuan* fauna.
- *New Holland* fauna.

VIII.—Polynesian Realm, inhabited by South Sea Islanders, and containing
- *Polynesian* fauna.

On the Geological Associations of Tellurium. By William Jory Henwood, F.R.S., F.G.S., Member of the Geological Society of France; Hon. M.Y.P.S., &c.; Mineral Surveyor to the Hon. East India Company.* (Communicated by the Author.)

It is remarkable that tellurium, in its native state, although discovered by Müller so long ago as 1782, has been found only in one locality—at Facebay in Transylvania—until now. Its alloys indeed have hitherto been detected in Norway, in Hungary, and in Siberia, only.

In Transylvania the native tellurium occurs in veins traversing a sandstone formation; but its alloys are found in lines which intersect a porphyritic rock; and both the metal and its compounds are accompanied by gold, sulphuret of antimony, and blende. In Norway bismuth is associated with them, and in Siberia they are mixed with lead.

Seven years have probably elapsed since I became acquainted with the occurrence of native tellurium in the mines of *Coelho* and *Paciencia*, near Morro de Sao Vicente, about thirty miles west of

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* From the Transactions of the Royal Geological Society of Cornwall.

Ouro Preto, the capital of Minas Geraës, in Brazil. The rock in the neighbourhood is a thin-bedded slate, usually talcose, and frequently containing chlorite also. The vein, which ranges through both mines, and is traced far beyond them on the line of its course, bears about E. and W. (magnetic), and is from twenty to forty feet in width. Its chief ingredients are hard milk-white quartz and quartzose slate. Though nowhere rich in gold, it is rarely destitute of it; the precious metal—sometimes in crystalline grains, the tellurium, and minute crystals of iron pyrites, sprinkling thinly, but tolerably regularly, the whole mass of the vein. There are, however, quartzose portions in which the tellurium occurs in large masses, presenting a confusedly crystalline structure, and sometimes long spiculæ of it are inclosed in translucent quartz.

During the summer of 1852, I visited—besides other parts of the United States—Spotsylvania county, near Fredericksburg, in Virginia. The *Whitehall* mine in that district is wrought in a deep blue clay slate. The *lodes* bear about S.E. and N.W. (magnetic), and are of considerable size; their principal constituent is a hard white quartz, sometimes marked with ferruginous stains, and occasionally they contain large masses of slaty matter. The gold, for which the mine was wrought, is for the most part scantily, but pretty uniformly scattered through the whole body of iron-tinged parts than elsewhere; where the quartz is somewhat drusy, it has occasionally a tendency to crystalline structure. The tellurium is, like the gold, only more scantily, dispersed through the quartzose matter; but no crystals of it have yet been discovered.

Distant as Minas Geraës and Virginia are from each other, the gold of the Morro de Sao Vicente neighbourhood has considerable resemblance to that of the Fredericksburg district; both, although of the very best quality, having an exceedingly slight tinge of green. Whether this hue may be from a minute portion of tellurium being naturally alloyed with the gold; or whether the two metals, being *stamped* together, are imperfectly separated by *dressing*, and form, when smelted together, an artificial combination, I am unable to say. No other natural union, however, if this be one, has yet been detected in either of these districts.

The sulphurets of antimony and of bismuth occur in the gold vein of *Catta Branca*, near Morro de Sao Vicente; iron pyrites and blende are mixed with the gold and tellurium of *Paciencia*; and galena is in like manner associated with them in many of the mines near Fredericksburg.

The engrossing occupations which have led me into these distant tracts, have not permitted me to search for the combinations of gold and tellurium; a reward probably reserved for some future inquirer better qualified for the task than I am, and with leisure for the pursuit, which I have not enjoyed.

3 CLARENCE PLACE, PENZANCE,
September 19, 1854.

SCIENTIFIC INTELLIGENCE.

MINERALOGY.

1. *Sir David Brewster on the origin of the Diamond.*—Sir David ascribes the origin of the diamond to a slow decomposition of plants. He met with a diamond which contained a globule of air, while the surrounding substance of the diamond had a polarizing (doubly refracting) structure, displayed by four sectors of polarized light encircling the globule. He therefore inferred that this air-bubble had been heated, and, by expansion, had produced pressure on the surrounding parts of the diamond, and thereby communicated to them a polarizing structure. Now, for this to have happened, the diamond must have been soft and susceptible of compression. But as various circumstances contribute to prove that this softness was the effect of neither solvents nor heat, he concluded that the diamond must have been formed, like amber, by the consolidation of vegetable matter, which gradually acquired a crystalline form by the influence of time and slow action of corpuscular forces.—(*Pereira's Lectures on Polarized Light.*)

2. *Polarity of Crystals.*—In crystals, it is necessary to admit, besides ordinary *attraction* and *repulsion*, a third molecular force, called *polarity*, which may be regarded either as an original or a derivative property. Without this, it is impossible to account for the regularity of crystalline forms. Under the influence of a mutually attractive force, particles would adhere together and form masses, the shapes of which, however, would be subject to the greatest variety; and though, occasionally, they might happen to be regular, yet this could not constantly be the case.

The simplest conception we can form of polarity is, that it depends on the unequal action of molecular attraction or repulsion in different directions. A molecule endowed with unequal attractive forces in different directions, may be said to be possessed of polarity. —(*Dr Pereira's Lectures on Polarized Light.*)

3. *Researches on Crystallization.*—M. Lavalle has recently presented to the French Academy a memoir narrating some remarkable phenomena discovered and patiently observed by him. All bodies, whose composition is clearly defined, have a tendency to crystallize; in other words, when they take the solid state slowly, their last particles, in grouping themselves, each after the other, are so disposed as to form a mass, which the mind successively decomposes into plane layers, into rectilinear files, and into elementary particles. As these are disposed parallel to each other, and at equal distances, to be arranged in files, so the layers are formed by the assembly of parallel and equidistant files; so, also, parallelism

and equality of distance preside at the aggregation of layers which compose the solid mass. It results from this, that the crystal is identical to itself throughout, and that any given particle affects in space, and in relation to the neighbouring particles, the same direction and the same relations as every other particle in every part of the mass. This regularity of interior structure is generally exhibited on the exterior by characteristic forms, which the practised eye can always detect. Varied as they may be, these forms may be reduced to a small number of species, which are called the crystalline system, and in which are naturally classed all real and possible crystals. Competent judges think nothing is more likely to reveal the existence of the elementary particle than the phenomenon of crystallization; for if the particle does not exist in the same form as that of the smallest sensible crystal, the last particles whose integrity seems necessary to the maintenance of the properties of the body must have particular and fixed directions. Be this as it may, we shall (perhaps) never see the particle itself; but this in no way lessens the interest of the phenomena connected with the mysterious operation of their free aggregation. It is to this point M. Lavalle's experiments were made. Among a good many curious experiments, M. Lavalle took a crystal of alum, a perfect octæd; he destroyed one of the six summits, and so made a square face, parallel to one of the faces of the corresponding cube; then, placing it upon this face, he abandoned it in the bottom of a box, containing a saturated solution; the crystal increased as usual, with perhaps what may be called the exception, that a face exactly like the square face on which it stood, was spontaneously produced on the opposite summit. Thus was confirmed by a striking example,—that great law of symmetry, which, in natural crystals, always opposes symmetrical faces. Another of his experiments was cutting away the angular edges of a crystal and the faces, so as to destroy completely all traces of its original form. But it must not be supposed that this will destroy its original nature; its structure will still remain; the experimenter has but to replunge it into the dissolution where it was formed, to see it complete itself, and cover again its angles and faces. It may happen, however, that this sort of restoration proceeds too rapidly, and that numerous small crystals shoot on the surface of the altered crystal. This gives a new piece of information; for all these small crystals have a common direction, which coincides with that of the mass from which they spring,—thus demonstrating the constancy of structure and the identity of the particles of which it is composed. We need not be astonished, then, that if a fragment of a crystal in process of formation be broken off, this loss will be promptly repaired. Nay, it is further seen, that, if a crystal is broken into fragments, each fragment soon reproduces in the saturated water an entire crystal, imitating in this respect *that marvel* of organization which, of one polypus, divided into several parts, makes in a few days so many entire polypi. Curious phenomena are produced when a crystal is transferred from one solution to another.

4. *Natural Deposit of Saltpetre.*—Professor W. H. Ellet, of the United States, reports that there has been discovered in Bradford County, Pennsylvania, a regular vein of nitre, believed to be unique in its character. The nitre occurs as a solid and uncrystalline deposit in the horizontal seams of a sandstone rock, and in veins proceeding from them at different angles; and the rock itself, which is quite porous, is abundantly charged with the same material. The nitre itself is very pure, containing more traces of nitrate of lime and magnesia. The sandstone in which it occurs is siliceous, containing a little carbonate of lime, and a notable quantity of silicate of potash.—(*The Dublin Monthly Journal of Industrial Progress*, No. viii., p. 242.)

5. *Artificial Formation of Minerals by Igneous Action.*—Professor Hausmann, of Göttingen, has recently published a memoir on the formation of minerals in and about furnaces, by furnace action. He enumerates the following varieties observed by him : silver, lead, copper, iron, bismuth, lead-glance, blende, oxide of zinc, red copper ore, iron-glance, magnetic iron-ore, crysolite, pyroxene containing alumina, Humboldtite, orthoclase, lead-vitriol, and arseniate of nickel brown, yellow, green, and black blende were observed formed in the furnaces of Lauten Valley, Hartz, in regular octahedrons and dodecahedrons ; also in lamellar and radiated concretions. Lead-glance, he says, is often formed by sublimations in the chimneys of furnaces, and the crystals are cubical with the usual cleavage ; and crystals of magnetic iron sometimes incrust cavities in the stone or brick work of the furnaces.

6. *The Use of the Microscope to Mineralogists.*—M. Dufour has made an important microscopical discovery that will be found useful in many circumstances. He has shown that an imponderable quantity of a substance can be crystallized, and that the crystals so obtained are quite characteristic of the substances. For example, he crystallized imponderable quantities of sugar, chloride of sodium, of arsenic, and of mercury, and the crystals obtained were quite characteristic of these substances. The mineralogist and toxicologist may find this process extremely valuable when the substance for examination is too small to be submitted to tests.—(*L'Institute*, No. 1067.)

GEOLOGY.

7. *Earthquake Indicator.*—M. Ratio-Menton, a gentleman connected with the French diplomatic corps in the Argentine Republic, has recently communicated to the Paris Academy of Sciences, in a letter addressed to the French Minister of Foreign Affairs, a

sure means of learning the approach of an earthquake. According to this gentleman, the earthquake indicator is nothing more than a magnet, to which is suspended, by magnetic attraction, a little fragment of iron. Shortly before the occurrence of an earthquake, the magnet temporarily loses its power, and hence the iron falls. According to M. Ratio-Menton, the accuracy of this indicative sign has been thoroughly tested by a highly educated Argentine officer, Colonel Epinosa, during a residence of many years at Arequipa, a region where earthquakes are very frequent. Independently of the authority of the communication, arising from the respectability of the communicator, and from its being published in the Transactions of the French Academy of Sciences, the result is nothing more than might have been suspected, from theoretical considerations of the alliance between electricity and magnetism. A disturbance of electric power has long been known to be associated with earthquakes.

8. *The quantity of Solid Matter carried annually to the Sea.*—Mr A. Taylor, in endeavouring to calculate the probable quantity of solid matter carried annually to the sea, either in a state of suspension or in a state of solution, by rivers or rivulets, or by other agents, has arrived at the conclusion that this quantity of sediment spread on the bottom of the sea, is capable to displace sufficient water to raise the level of the ocean three inches in 10,000 years. This is an important statement, and ought to be borne in mind, when calculating on the changes that our earth has undergone during its formation. He has also calculated the denudation of sediment over 100,000 square miles of North America, spread by the Mississippi, ought, if its river has always been charged with sediment as it has always been in our days, to have lowered the surface of the earth one foot in 9000 years, and that the Ganges produced the same effect in its hydrographic basin in 1794 years.—(*L'Institut*, No. 1067.)

9. *Origin of the Bitumen of Stratified Rocks.*—Table showing the Geological position of Petroleum Springs,—

The super-cretaceous rocks of South America, the cretaceous of Syria, the oolite of France, and the lias of Europe, furnish 15 instances.

The coal series and carboniferous rocks, .	8	...
The Devonian rocks, ...	13	...
The Silurian, ...	12	...
The metamorphic and magnesian, . .	6	...
Total, .	54	

of these 54, 31 are below the carboniferous and coal-producing rocks; and 23 are in or above the coal series; of the number of 23, 15 are due to the rocks from the lias upward; 8 only belonging to the coal-bearing strata.

In the present state of knowledge, therefore, the rocks below the coal, produce about four times as much liquid and coagulated bitumen as the carboniferous strata, and one quarter more than all the rocks above the Devonian. The mica slate, serpentine, and magnesian beds, explored by Mr Taylor in Cuba, are doubtless the equivalent of the Azoic system of Lake Superior, and older than the Potsdam sandstone. Mr Taylor regards all the bitumen of the West India Islands, including the Pitch Lake of Trinidad, as belonging to the same age.

In the mine of Consualidad, near Havana, he found asphaltum in a vein or fissure of the metamorphic rock, which, at the bottom of the shaft, attained the thickness of 9 feet. On the Tapaste, and on the Matanzas road, he saw it in the same rocks, in still greater masses, whose dimensions had been penetrated more than 100 feet, without finding the sides. In those islands, asphaltum rises to the surface from beneath the sea, after volcanic action has been experienced. The great lake of Trinidad, 3 miles in circumference, he considers as supplied from the rocks of the same age, as those he inspected around Havana. The specimens observed by Mr Logan on the east coast of Lake Superior, were in rocks doubtless not newer than the Potsdam. Those streams of naphtha seen by Humboldt issuing from mica slate, in the Gulf of Cariaco, in Venezuela, were without doubt flowing from the most ancient rocks, and the same may be said of the gneiss containing iron, in Scandinavia, in which liquid bitumen is found. Everything points to an early, a very ancient existence of bitumen, both solid and liquid, in the rocky strata of our planet.

Was it not *as ancient* as any of the compound substances comprising these strata.

The systems composed of magnesian slates, magnetic iron ore, mica slate, and magnesian limestone, which are so well developed on Lake Superior, in Missouri, and in Sweden, are older than most of the granites. Rocks that are apparently of the same age, or at least more ancient than any traces of animal or vegetable life in Cuba, in Scandinavia, and in Canada, contain bitumen.

This assertion has not, it is true, a perfectly incontestable basis whereon to rest, but a reasonably good foundation, approaching to a mathematical demonstration. Aside from the facts here presented, the assertion is not theoretically a strange or startling one.

The components, or simple substances of which bitumen is constituted, existed from the earliest creation. Oxygen must have been in existence as early as the metals; otherwise they would be found pure, and in the form of alloys, and not of oxides. We must suppose that there was iron ore, lime, silica, magnesia, and other oxides, alkalies and earths, as soon as there was calcium or silicium.

Oxygen gas, which constitutes about one-fourth of the mass of the globe, must have been primeval. Are not chlorine, sulphur, nitrogen, hydrogen, and carbon equally ancient? Is there any rock so old that it does not contain sulphur. The dolomites of the metamorphic rocks contain carbon; and the carbonates generally carry about *one-eighth* of their mass of this singular substance, which is sometimes an imperceptible vapour, and acquire the hardest kind of matter known. These dolomites are sometimes found older than the Potsdam sandstone. Nitrogen may not have been found in rocks below the mountain limestone, where it exists in the form of the nitrate of potassa. But nitrogen must have been in being before organic life; for it is one of the component parts, and there could not have been an atmosphere fit for respiration without it.

Hydrogen is not found in combination with the strata of the early geological eras; but hydrogen must have been present, with oxygen, before water could have been formed; and consequently, before the deposition of any sedimentary rock. If the ancient seas which deposited the Silurian system, were, as their fossils prove them to have been, salt, then their water contained chlorides and chlorine in the same manner as our seas do at the present day.

All the gaseous substances exist now in a free state in the oldest sedimentary strata, and flow out in combination with salts in thousands of mineral springs. The thermal springs that proceed from great depths in the lowest and oldest rocks, bring up carbonated hydrogen and other gases, and chlorides, carbonates, &c., in solution. Almost all the salt wells and the petroleum springs in the above list evolve gases, some of them pure nitrogen, and salts of various kinds. All those kindred substances are found wherever man has penetrated the earth or divined its composition, in the oldest as well as in the most recent formations, and they include all the constituents of bitumen.

Chemists regard the various forms of native bitumen, whether under the name of naphtha, petroleum, seneca oil, mineral tar, or asphaltum, as essentially the same compound mixed with different proportions of earthy matter, or exposed more less to the atmosphere, which coagulates and hardens it. It is an *atomic combination* of carbon and hydrogen—6 atoms of each. In the atmosphere it absorbs oxygen and nitrogen. From the same rocks and the same depths there issues in company with naphtha, petroleum, &c., an inflammable or light carburetted hydrogen gas, composed of 1 *atom* of carbon to 2 of hydrogen.

Having convincing proofs that the elementary substances comprising bitumen were in existence and universally diffused in nature before the production of organic life, with the same chemical affinities they now possess and obey, is it philosophical to suppose that they did not, when in contact, obey those affinities until after animals and vegetables were created? Is it not equivalent to the assertion that carbon and hydrogen did not unite in the proportion of 6 atoms of each, nor of 1 atom of carbon to 2 of hydrogen, till after they had been elaborated in the vessels of a planet, or the stomach of an animal? Is it not more philosophical to reverse the process, and to say that animal and vegetable life derives its material substance by a power of accretion from what existed before, in a mineral state; and from gases *coeval* with the primitive minerals?

10. *Strength and Density of Building Stone.*—By a series of experiments recently tried in Washington, under the direction of the Ordnance Board, the specific gravity of various sandstones presented, averaged 1,929; the best Quincy granite, or to speak properly, Sienite, 2,648, and the Malone sandstone 2,591.

The report of the examining officers further states—

1*st*, That the sandstone of the capitol broke under a pressure, per square inch, of 5,245 lb.

2*d*, Several of the marbles tested broke under pressures varying from 7000 to 10,000 lb.

3*d*, The compact red sandstone, of which the Smithsonian Institute is built, broke under 9,518 lb.

4*th*, The granite, or blue micaceous rocks, employed for the new foundations, broke (as the average of 7 samples) under 15,603 lb.

5*th*, The Malone sandstone, 24,105 lb.

6*th*, The most compact Sienite from Quincy, 29,220 lb.

It should be mentioned, that the various sandstones were tested in the weakest position,—with the lines of stratification perpendicular to the horizon, as such is the way that they are usually employed in building. The marbles and granites were tested in an exactly opposite position.

11. *Theory of Earthquakes.*—A report of the committee of the Institute of France, consisting of MM. Lionville, Lamé, and Elie de Beaumont, on the subject of the theory of earthquakes, has been transmitted to me for the use of the Association. From a careful discussion of several thousand of these phenomena, which have been recorded between the years 1801 and 1850, and a comparison of the periods at which they occurred with the position of the moon in relation to the earth, the learned Professor, M. Perrey of Dijon, would infer that earthquakes may possibly be the result of an action of attraction exercised by that body on the supposed fluid centre of our globe, somewhat similar to that which she exercises on the waters of the ocean; and the report of the committee of the Institute is so far favourable, that at their instance the Institute have granted funds to enable the learned Professor to continue his researches. You will recollect how often the attention of the Association has been drawn to this subject by the observations of Mr Milne and of Mr Mallet, which latter are still going on, and that the accumulating facts are still waiting for a theory to explain them.—(*From the*

Right Hon. the Earl of Harrowby's Address to the British Association at Liverpool.)

ETHNOLOGY.

12. *Agassiz on the Specific Difference of the Human Races.*—Professor Agassiz's researches in embryology possess most important bearings on the natural history of mankind. He states, for instance that during the fœtal state, it is in most cases impossible to distinguish between the species of a genus; but that, after birth, animals being governed by specific laws, advance each in diverging lines. The dog, wolf, fox, and jackal, for example, the different species of ducks, and even ducks and geese, in the fœtal state cannot be distinguished from each other; but their distinctive characters begin to develop themselves soon after birth. So with the races of men. In the fœtal state there is no criterion whereby to distinguish even the Negro's from the Teuton's anatomical structure; but after birth, they develop their respective characteristics in diverging lines, irrespectively of climatic influences. This he conceives to be a most important law; and it points strongly to *specific* difference.

METEOROLOGY.

13. *The importance of correct Scientific Instruments at Sea.*—I would take the liberty of quoting further:—"There are risks at sea against which no foresight can provide; but loss from defective compasses, or ill-regulated chronometers, should be treated as a crime, since common sense and common care will secure the efficacy of both these instruments. It is to be feared that life and property to a large amount are yearly sacrificed for want of a little elementary knowledge, and a small amount of precaution on the part of our seamen, who neglect the safeguards furnished by modern science." You will perhaps forgive me for taking the liberty of urging upon you the importance of continuing to them an unabated if not an enlarged support. By giving accuracy to the various instruments of observation, the thermometer, the barometer, and the standard weights and measures, they are doing a work of incalculable benefit to science in general in this and in other countries. At this moment they have in their hands for verification and adjustment one thousand thermometers and fifty barometers for the navy of the United States, as well as five hundred thermometers and sixty barometers for our own Board of Trade, the instruments which are supplied in ordinary commerce being found to be subject to error to an extraordinary degree. At the suggestion of Sir John Herschell, they have also undertaken, by the photographic process, to secure a daily record of the appearance of the sun's disc, with a view of ascertaining, by a comparison of the spots upon its surface, their

places, size, and forms, whether any relation can be established between their variations and other phenomena.—(*From the Right Hon. the Earl of Harrowby's Address to the British Association at Liverpool.*)

BOTANY.

14. *The Age of the Cypress Forests.*—The plain on which the city of New Orleans is built rises only nine feet above the sea, and excavations are often made far below the Gulf of Mexico. In these sections several successive growths of cypress timber have been brought to light. In digging the foundation for the gas-works, the Irish spadesmen, finding they had cut through timber instead of soil, gave up the work, and were succeeded by a corps of Kentucky axemen, who hewed their way downwards through four successive growths of timber, the lowest so old that it cut like cheese. Abrasions of the river banks show similar growths of sunken timber, while stately live oaks, flourishing on the banks directly above them, are living witnesses that the soil has not changed its level for ages. Messrs Dickeson and Brown have traced no less than ten distinct cypress forests at different levels below the present surface, in parts of Louisiana where the range between high and low water is much greater than it is at New Orleans. These groups of trees (the live oaks on the banks and the successive cypress beds beneath) are arranged vertically above each other, and are seen to great advantage in many places in the vicinity of New Orleans. Dr Bennet Dowler has made an ingenious calculation of the last emergence of the site of that city, in which these cypress forests play an important part. He divides the history of this event into three eras—1. The era of colossal grasses, trembling prairies, &c. as seen in the lagoons, lakes, and sea coast; 2. The era of the cypress basins; 3. The era of the present live oak platform. Existing types, from the Belize to the highlands, show that these belts were successively developed from the water in the order we have named, the grass preceding the cypress, and the cypress being succeeded by the live oak. Supposing an elevation of five inches in a century (which is about the rate recorded for the accumulation of detrital deposits in the valley of the Nile during seventeen centuries by the Nilometer mentioned by Strabo), we shall have 1500 years for the era of aquatic plants until the appearance of the first cypress forest, or, in other words, the elevation of the grass zone to the condition of a cypress basin.

Cypress trees of ten feet in diameter are not uncommon in the swamps of Louisiana, and one of that size was found in the lowest bed of the excavation at the gas-works in New Orleans. Taking ten feet to represent the size of one generation of trees, we shall have a period of 5700 years as the age of the oldest trees now growing in the basin. Messrs Dickeson and Brown, in examining the cypress timber of Louisiana and Mississippi, found that they measured from 95 to 120 rings of annual growth to an inch, and, according to the lower ratio, a tree of ten feet in diameter will yield 5700 rings of annual growth. Though many generations of such trees may have grown and perished in the present cypress region, Dr Dowler, to avoid all ground of cavil, has assumed only two successive growths, including the one now standing; this gives us in the age of the two generations of cypress 11,400 years.

The maximum age of the oldest tree growing on the live oak platform is estimated at 1500 years, and only one generation is counted. These data yield the following table:—

Geological Chronology of the last Emergence of the present Site of New Orleans.

Era of aquatic plants, . .	1,500	years.
„ of cypress basin, . .	11,400	„
„ of live oak platform, . .	1,500	„
Total period of elevation,	14,400	„

Each of these sunken forests must have had a period of rest and gradual depression, estimated as equal to 1500 years, for the duration of the live oak era, which of course occurred but once in the series. We shall certainly, then, be within bounds if we assume the period of such elevation to have been equivalent to the one above arrived at; and, inasmuch as there were at least ten such changes, we reach the following result:—

Last emergence as above, . .	14,400	years.
Ten elevations and depressions, each equal to the last emergence, . . .	144,000	„
Total age of the Delta,	158,400	„

In the excavation of the gas-works above referred to, burnt wood was found at a depth of sixteen feet, and at the same depth the workmen discovered the skeleton of a man. The cranium lay beneath the roots of a cypress tree belonging to the *fourth* great level below the surface, and was in good preservation. The other bones crumbled to pieces on being handled. The *type* of the cranium was, as might have been expected, that of the *aboriginal American race.*

If we take, then, the present era at .	14,400	years,
And add three subterranean groups, each equal to the living (leaving out the fourth, in which the skeleton was found),	43,200	„
We have a total of	57,600	„

From these dates it appears that the human race existed in the delta of the Mississippi more than 57,000 years ago; and the ten subterranean forests, with the one now growing, establish that an exuberant flora existed in Louisiana more than 100,000 years earlier, so that 150,000 years ago the Mississippi laved the magnificent cypress forests with its turbid waters.—(*Sir J. C. Nott and Geo. R. Gliddon, Esq., on the Types of Mankind.*)

15. *The Effect of Coloured Light on Germination.*—To determine the commercial value of any seeds, one hundred of them are placed in a pot in a stove-house for the purpose of quickening the process of germination. If all the seeds germinate, the seed obtains the highest value in the market. If only eighty germinate, the seed loses 20 per cent. in value. This process ordinarily occupies from twelve to fifteen days; but Mr Lawson found that by using blue glass they are enabled to determine the value of seed in two or three days; and this is a matter of such commercial importance to them that it is quite equal to a gift of L.500 a-year.—(*Proceedings of the Royal Polytechnic Society.*)

16. *Origin of the Wheat Plant.*—Some curious botanical facts have recently been laid before the French Academy, relative to the transformation of two grasses, Ægilops ovata and the Ægilops triaristata. M. Esprit Fabre of Adge, in France, has shown that the above grasses were capable of being the source of all or the greater part of our species of wheat. He first sowed the seed of the *Ovata* in the fall of 1838. In 1839, the plants grew to a height of two feet, and ripened in the middle of July. The ears here and there had one or two grains in them. The crop was five for one, and the straw was brittle and thin. In 1840, the seed of 1839 produced ears more numerous, and generally each contained a couple of grains of an appearance more like wheat. In 1841, the ears were more like wheat, and each had from two to three grains. The figure of the plant was almost like wheat. In 1842, the fourth year of his experiments, the progress was not so sensible as in the previous year. Many of the plants were attacked by rust. The stalks were like *Ægilops.* The ear gave two or three grains each. In 1843, the stalks grew two feet high. In each ear were two or three well-grown grains, and the straw was stronger. The figure of the plant was like wheat. In the year 1844, all the ears were filled. In 1845, the seventh year, the plant had reached the condition of true wheat. These experiments were made in an inclosure surrounded by high walls. There was no grass inside of it, and no grass raised near the spot. In 1846, he sowed this grain in a field broadcast, and continued it four years. In 1850, the straw was full, straight, over two feet high, and each ear contained two or three dozen grains of perfect wheat. Thus a savage plant, subject to cultivation, changed its entire figure and aspects, and gradually assumed a new character.

17. *A New Invention for increasing the Produce of Autumn Wheat. By M. D'Urcle.*—The inventor grounds his discovery upon the fact positively ascertained "by study and repeated experiments"—that autumn wheat is not an annual, but biennial, like the beet-root and carrot class; and he therefore proceeds to develop the alleged biennial properties by a novel plan of planting and treatment, for the increase of the produce. The ground is to be well manured, either before winter or at the beginning of spring, to receive the seed between the 20th of April and the 10th of May, this time being chosen to prevent the chance of blossoming during the year. But the time of sowing may be advanced from year to year; for, if it were not for the present degeneracy of the plant, it might occur now in March. Each grain is sown separately, allowing it a large area of ground, if the soil is rich, but diminishing according to its sterility. It is deposited in rows, in holes, at regular distances, from 9½ to 23½ inches asunder, in each direction, the holes in one row opposite the spaces in the next. Each hole is to contain four or five grains 2½ inches asunder. When the plants have attained a height of 4 inches, all but the finest one in each group are pulled up, and this single one is then left in till the harvest of the succeeding year. This curious process is stated to increase the produce very greatly.

18. *The Preservation of the Properties of Soil.*

63 Northumberland Street, September 4, 1854.

SIR,—In the July number of the Edinburgh New Philosophical Journal, at page 170, it is observed that Schleiden considers ploughing as "a necessary evil, and one only to be employed so far as necessity requires." Permit me to observe, that in some of the western states of America (Indiana, for instance) I found this opinion prevalent, the farmers insisting that to expose the soil to the free action of weather is about as rational as to act in the same manner with a heap of manure, the valuable salts being in each case, to a greater or less extent, removed.—I remain, your obedient servant,

A. OSWALD BRODIE.

ASTRONOMY.

19. *The Present State of Astronomy.*—Since the meeting of the British Association last year, four planets and four comets have been discovered. Three of the new planets were found at Mr Bishop's observatory, two by Mr Hind, and one by Mr Maith. This last was also discovered the following night at the Oxford observatory, —another of the many instances presented by astronomy of independent discoveries made nearly simultaneously. The fourth planet was found at the observatory of Bilk, near Dusseldorf, by Mr R. Luther, an astronomer distinguished by having already discovered

two planets. Of the comets, one was discovered at Berlin, two at Göttingen, and the fourth was seen very generally with the naked eye to the end of last March. None of them have been identified with preceding comets.—(*From the Right Hon. the Earl of Harrowby's Address to the British Association at Liverpool.*)

MISCELLANEOUS.

20. *New Method of procuring Coloured Silk from the Cocoons.*—It has long been known to physiologists that certain colouring matters, if administered to animals along with their food, possessed the property of entering into the system and tinging the bones. In this way the bones of swine have been tinged purple by madder, and instances are on record of other animals being similarly affected. No attempt was made to turn this discovery to account until lately, when Mons. Roulin speculated on what might be the consequences of administering coloured food to silkworms just before spinning their cocoons. His first experiments were conducted with indigo, which he mixed in certain proportions with mulberry leaves serving the worms for food. The result of this treatment was successful—he obtained blue cocoons. Prosecuting still further his experiments, he sought a red colouring matter, capable of being eaten by the silkworm without injury. He had some difficulty to find such a colouring matter at first, but eventually alighted on the *Bignonia Chica.* Small portions of this plant having been added to the mulberry leaves, the silkworms consumed the mixture, and produced red coloured silk. In this manner the experimentalist, who is still prosecuting his researches, hopes to obtain silk, secreted by the worm, of many other colours.

21. *The value of Polarization to the Optician and Glass Manufacturer.*—To the optician, it is of the highest importance that the glass of which lenses and prisms are made should possess uniform density, and be free from all defects arising from irregularities in the annealing process. To detect these, the glass should be carefully examined by polarized light previous to being ground and polished, and, by this agent, the slightest defects are made appreciable. So also glass vessels, employed for domestic purposes, may be advantageously tested by the same agent.—(*Pereira's Lectures on Polarized Light.*)

22. *Practical value of the Optical characters of Sugar.*—The optical characters of sugar have been made use of to detect fraud in pharmacy. In 1842, more than a ton of a substance, purporting to be *manna,* was offered for sale in Paris at less than 5d. per pound; the excuse given for the unusually low price was, that cash was immediately required. Suspicion was raised, and the substance was submitted to careful examination, the result of which was the esta-

blishment of the fact, that it was not manna, but potato sugar. Its aspect, taste, fermentability (mannite not being fermentable), and the presence of the sulphate of lime, proved this. Biot submitted it to a very careful optical examination, and found its characters to be those of a starch sugar. Manna contains two kinds of saccharine matter, one called mannite, and the other a *fermentable sugar*. Now, mannite, when pure, has no rotative power on polarized light, but commercial manna has a slight effect, owing to the presence of a small quantity of fermentable sugar. This fictitious substance, however, had the same effect on plane polarized light, as sugar prepared by the action of acids on starch, when the action is arrested at the first phase of its transformation.—(*Pereira's Lectures on Polarized Light.*)

23. *Polarized Light used in detecting Vinous Fermentation.*—Take a solution of cane sugar, which has *right-handed* circular polarization. As soon as it begins to ferment, it loses this property, but acquires *left-handed* polarization.—(*Pereira's Lectures on Polarized Light.*)

24. *The use of Polarized Light as a Test for Sugar.*—Some kinds of *sugar*, when dissolved in water, yield solutions, which have, in a greater or less degree, the property of rotating the planes of polarization, some to the right, others to the left. Hence, polarized light may be sometimes used as a test of the presence of sugar, and the degree of rotation becomes an indication of the quantity and even quality of the sugar present. Biot examined by this test a specimen of sugar-cane juice, and found that it indicated the presence of 20 or 21 per cent. of sugar. Peligot subsequently analyzed it, and found 20·9 per cent. of sugar. Biot, therefore, suggests that those who make, as well as those who refine sugar, might resort to this test as a means of determining the amount of sugar in different juices or solutions. To the colonist, it would prove useful, by pointing out the saccharine strength of the juice at the mill, and to the sugar refiner it would be valuable, by enabling him to determine the absolute strength of raw sugar.—(*Pereira's Lectures on Polarized Light.*)

25. *The Value of the Microscope for detecting the best kinds of Wool for Felting.*—Microscopic discoveries have been made within the last few years, which have led to a revelation of much of the mystery of felting. Examined through a powerful microscope, the short fibres exhibit the appearance of a continuous vegetable growth, from which there are sprouting and all tending in one direction from the root to the other extremities, numerous leaves like calices or cups, each terminating in a short point. It is easy to perceive how easily one of these fibres will move in the direction from root to point,

while its retraction must be difficult, being obstructed by the tendency of the little branches. In a fibre of merino wool, the number of these reversions or projections amounted to 2400 in the space of one inch. In a fibre of Saxon wool of acknowledged superior felting quality there were 2720 senations. Southdown wool, being inferior to those two for felting power, only contained 2080 senations in one inch of fibre, while Leicester wool contained no more than 1860 in one inch; and Leicester wool is known to be little adapted for felting purposes.

26. *Present state of Agriculture.*—A perfected agriculture can result only from nice adjustments—a determination of the nature of the matter to be dealt with, and its inherent forces, combined with a special knowledge of the individual organization and its functional wants. Defective products are mainly due to functional wants; there are no truly diseased products or disorganized organs. Graduate the supplies to the nutrient powers, satisfy the capacities of the plant at the proper time, and, all other things being adjusted, the husbandry is perfect; or give the plant its climate, temper the heat and moisture to its constitution, make its physical condition happy, and put within its reach the assimilating elements, and enough is done to ensure productive returns. But to do this requires probably more knowledge of soils, and of the cultivated vegetables, than we now possess. The object is to supply without waste, to cheapen the product by the expenditure of the least labour, and restricting the food to the kind and quantity, so that it shall not be lost by escaping into the air, or being washed to remote parts by rains. It is evident that adjustments require a complete insight into the physiology of vegetation—its incipient stage, its maturing strength, the peculiar or special products to be formed, the elements composing them, and the best form in which these elements can be combined to meet all the wants of the being. As I have already said, functional endowments must be considered; hence, to pursue that course with a plant which will give it an early vigorous constitution, a full development of its organs in its first stages, and the foundation is laid for the full amount of the products sought.—(*Emmons' Natural History of New York.*)

NEW PUBLICATIONS RECEIVED.

1. **Siluria.** The History of the Oldest Known Rocks containing Organic Remains, with a brief Sketch of the Distribution of Gold over the Earth. By Sir Roderick Impey Murchison. London: John Murray, Albemarle Street.

This will remain the standard work on geology for many years to come; and as it contains much novel information not to be found in any other work, it ought to be in the hands of every geologist.

2. Lectures on Polarized Light, together with a Lecture on the Microscope. By the late Jonathan Pereira, Esq., M.D.; second edition, greatly enlarged, from materials left by the Author. Edited by the Rev. Baden Powell, M.A., V.P.R.S. London: Longman, Brown, Green, and Longmans, 1854.

We find in these Lectures many valuable practical facts that illustrate well the great value of science of a high order. The author shows us that the study of polarized light not only furnishes us with an intimate knowledge of the nature and properties of substances; but also its applicability to the detection of adulteration of goods, drugs, and chemicals; for example, the determination of the commercial value of saccharine juices—the nature of changes which occur in certain chemical and vital processes, in which ordinary chemical analysis fails—the detecting of the existence of certain diseases—and its use to the mariner in aiding him to avoid shoals and rocks. These Lectures are extremely valuable to the student of natural philosophy.

3. The Westminster Review for July 1854.

4. Transactions of the Bombay Geographical Society, 1854.

5. On the first Hurricane of September 1853, in the Atlantic; with a Chart, and Notices of other Storms. By W. C. Redfield.

6. American Journal of Science and Arts, up to May 1854.

7. Annalen der Physik und Chemie, Herausgegeben zu Berlin. Von J. C. Poggendorff. Nos. vi., vii. Leipzig, 1854.

8. L'Institut, Journal Universell des Sciences et des Sociétés Savans ent France et à l'Etranger, up to August 1854.

9. Bibliothèque Universelle de Genève. Archives des Sciences Physiques et Naturelles. Genève, August 1854.

10. Quarterly Journal of the Chemical Society. Nos. xxv., xxvi.

11. The Journal of the Indian Archipelago and Eastern Asia, up to April 1854; Journal of the Asiatic Society of Bengal, 1854.

12. Pharmaceutical Journal and Transactions. London: August 1854.

13. The Dublin Monthly Journal of Industrial Progress, up to September 1854.

14. Journal of the Asiatic Society of Bengal. Nos. i., ii. New Series. 1854.

15. Annual Report of the Royal Cornwall Polytechnic Society. 1853.

16. The Quarterly Journal of Microscopical Science, for July 1854.

17. New York North-Western Medical and Surgical Journal. May 1854.

18. Jahrbuch der Kaiserlich-Koniglichen Geologischen Reichsanstalt. IV., Jahrgang. No. 1, January, February, March; and No. 4, October, November and December. 1853. Wien.

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